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RESPONSE OF RICE TO FERTILIZATION IN FOUR SOUTHERN LUZON PROVINCES [1]

N. L. Galvez, T. C. Cruz, M. E. Raymundo,
J. G. Davide, and P. A. G. Santos

Not one of the 20 field experiments using various rates, sources, times, and methods of surface application of nitrogen with or without phosphorus and potassium responded to potassium.

The response to fertilization was not consistent. Calumpang clay in Calauan, Laguna, planted to Guinangang and Guadalupe clay in San Pedro, Laguna, planted to Ramelon responded to nitrogen alone. Guadalupe clay in Pamplona and Talon, both in Las Piñas, Rizal, needed split application of nitrogen and phosphorus applied before booting for a good yield of Macan.

The yields of Wagwag rice on Lipa loam in Gatid, Sta. Cruz, and in the UP College of Agriculture and Central Experiment Station were adversely affected by the early application of nitrogen. Late application did not influence the yield. Response to phosphorus was hinted in the lowland field of the College.

Lipa loam in Banay-banay, Lipa City, and in Maquiling, Calamba, Laguna, increased its yields of Kinanda rice variety after application of nitrogen alone. Ibaan loam in Pinagtungulan planted to Dumali was improved by the use of nitrogen alone. Guadalupe clay in Muntinlupa, Rizal, needed nitrogen with phosphorus for a good yield of Kinanpupoy rice variety.

As shown by the response of Guinangang rice variety to fertilizers, Calumpang clay in Tabon, Bay, had a higher fertility level than that in Calauan. Calumpang clay in Hangan, Bay, had a fertility level parallel to that in Masiit, Calauan, as shown by the yield of Thailand rice variety.

An increase of about 10 cavans may be expected from the addition of 30 kg. nitrogen to lowland fields responsive to fertilization and 15 cavans from upland fields. Nitrogen from ammo-phos was as effective as nitrogen from ammonium sulfate.

In soils requiring nitrogen with phosphorus, the application of 60-25-0 may increase the yield by about 15 cavans per hectare. In Guadalupe clay in Rizal, nitrogen from ammo-phos increased the yield of rice more than the same rate of nitrogen from ammonium sulfate.

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[1] Central Experiment Station Contribution No. 1865. The study was carried out at the instance of Dr. N. C. Brady, formerly visiting Cornell professor in the Department of Soils (1953-54). Statistical computations were done in the Division of Statistics. Part of the expenses was from a Mathieson-Menzi research grant.

In general, lowland soils contained higher average amounts of organic matter and available phosphorus than upland soils. This may partly account for the more responsive characteristics of upland soils to fertilization than lowland soils. The relation between organic-matter content of the soil and response to fertilization was inconsistent, however.

Soils with fair to good irrigation were generally more inconsistent in their response; those entirely dependent on rainfall were responsive to fertilization. The best rate, source, time, and method of surface application varied with soil series, rice variety, and source of irrigation water.

Guadalupe clay in Laguna contained sufficient available phosphorus for growing rice. Its value was much higher than Guadalupe clay in Rizal, the ratio being 10:1. Guadalupe clay in Rizal was very deficient in nitrogen and phosphorus for growing rice. Calumpang clay, Lipa loam, and Ibaan loam contained sufficient available phosphorus for growing rice.

The degree of soil exhaustion varies with the soil types, rice varieties, and soil management practices. Consequently, so does soil response to fertilization. Rice fertilization experiments should therefore be conducted in various soil types.

While the use of fertilizers is not new to the Filipino rice farmers, data on the necessity of certain fertilizing elements are very limited. The object of this work was to determine whether or not the present use of fertilizers in four southern Luzon provinces increases the yields of rice.

MATERIALS AND METHODS

Representative rice fields in Laguna, Batangas, Rizal, and Quezon were used as experimental fields. Soil analyses of these fields are shown in table 7. The fields were prepared and planted by the farmers in the usual way. After the plants had established themselves, the treatments were applied. Each treatment was replicated four times, each replication being laid out in a single paddy.

Unlike the usual practice, no dikes were made between the treated plots of the lowland rice fields. Instead, the field was drained of its excess water before the fertilizer was applied. Seven to ten days after the application of the fertilizer, irrigation water was allowed to enter the field slowly. In so doing, the movement of fertilizer from one plot to another was prevented. One indication of this was the well-defined boundary between the plots given nitrogen and those that were not.

Most of the upland rice fields had been planted to rice early in the season followed by either corn or mungo. Mungo, however,

was planted not as green manure but as a source of additional cash income. It therefore also removed from the soils so much available nutrients like calcium, phosphorus, magnesium, and potassium.

All the fertilizers were applied to the surface. The sources of nitrogen were ammonium sulfate containing 20 per cent nitrogen and ammo-phos containing 16 per cent nitrogen and 20 per cent P_2O_5. Superphosphate was used as the source of P_2O_5, and muriate of potash, of K_2O.

RESULTS AND DISCUSSION

General observations. Vegetative response to nitrogen was very apparent. The nitrogen-treated plots had taller plants with broader and greener leaves than the untreated plots. Early application of nitrogen produced more tillers which, when not given more nitrogen, became even lighter in color than those in the control plots. The appearance and tendency of the rice plants to lodge were closely associated with the amount of nitrogen and depth of the mud.

Of the 20 fertilizer field tests not one responded to potassium, which may be attributed to the fact that soils derived from the weathering of volcanic materials contain adequate potassium.

Response to fertilization of lowland soils. It is evident in table 1 that the 22.5 and 45 kg. rates of nitrogen applied two weeks after planting did not increase the yield of Guinangang rice variety grown on Calumpang clay in Tabon, Bay (RF-1). The difference between the means for the 0 treatment and the 90 treatment was insignificant.

The same treatments applied in the same manner to Lipa loam in Lalakay, Los Baños, (RF-2) did not also increase the yield of Dinurado rice variety. There was also no response to phosphorus.

The 20 and 40 kg. rates of nitrogen from ammonium sulfate applied to Lipa loam in Mabolo, Calamba, (RF-3) two weeks after planting did not increase significantly the yield of Sinan Antonio rice variety (table 2). Nitrogen from ammo-phos showed a trend of results similar to that of nitrogen from ammonium sulfate.

Clay in Mayao, Lucena, Quezon, (RF-8) applied with 20 and 40 kg. nitrogen from ammonium sulfate two weeks after planting did not increase its yield of Mangasa rice. The yield was about 10 cavans lower than in other places in the Philippines. Evidently the presence of phosphorus in ammo-phos did not change the trend of results.

TABLE 1.—*Response of lowland rice to nitrogen without or with phosphorus applied two weeks after planting* [a]

EXPER. NO.	VARIETY	N TREATMENT	P_2O_5 TREATMENT		AVERAGE YIELD
		kg./ha.	0	90	
			yield in cav./ha. (15% moisture)		
RF–1 [b]	Guinangang	0	65.4	67.5	66.5
		22.5	65.9	64.5	65.2
		45	66.6	62.3	64.5
Average			66.0	64.8	
RF–2 [c]	Dinurado	0	52.2	61.0	56.6
		22.5	54.9	59.6	57.3
		45	52.8	58.0	55.4
Average			53.3	59.5	

[a] Part of theses of A. Sobrepeña and E. Sindico (1955).
[b] Calumpang clay in Tabon, Bay, Laguna.
[c] Lipa clay loam in Lalakay, Los Baños, Laguna.

It may also be seen in table 2 that the 20 and 40 kg. rates of nitrogen from ammonium sulfate given in split application to Calumpang clay in Calauan (RF-4) markedly increased the yield of Guinangang rice variety. The yields of the plots fertilized with 20 and 40 kg. of nitrogen were 11.4 and 14.5 cavans higher, respectively, than that of the control. The 40 kg. rate was only as efficient as the 20 kg. rate. The yields of the plots fertilized with the two rates of nitrogen from ammo-phos were identical to those fertilized with corresponding rates from ammonium sulfate.

TABLE 2.—*Response of lowland rice to various rates and sources of nitrogen*

RATE	SOURCE	RF-3 [a]	RF-8 [b]	RF-4 [c]
		yield in cavans/ha. (15% moisture)		
0– 0–0	$(NH_4)_2SO_4$	73.8	41.2	64.4
20– 0–0		81.8	44.9	75.8
40– 0–0		84.5	49.3	79.4
20–25–0	Ammo-phos	79.2	45.1	78.9
40–50–0		81.2	44.6	77.5
SMD				5% (T)—6.55

[a] Lipa loam, Mabolo, Calamba, Laguna, planted to Sinan Antonio, fertilized two weeks after planting.
[b] Guadalupe clay, Mayao, Lucena, Quezon, planted to Mangasa, fertilized two weeks after planting.
[c] Calumpang clay, Calauan, Laguna, planted to Guinangang. One half of fertilizer was applied at planting and the other half six weeks after.

It may be noted in table 3 that the application of 40 kg. nitrogen from ammonium sulfate to Calumpang clay in Hangan, Bay, (RF-5) and in Masiit, Calauan, (RF-6) two weeks or six to seven weeks after planting did not increase the yield of Thailand rice variety. Split application of the fertilizer did not influence the yield.

Nitrogen from ammo-phos gave results parallel to those of nitrogen from ammonium sulfate. It should be noted, moreover, that the yield of about 86 cavans per hectare of the control was much higher than the average yield of palay in the Philippines.

Table 3 shows further that Guadalupe clay in Pulo, Sta. Rosa, was not responsive to fertilization. The application of 40 kg. nitrogen from ammonium sulfate at the different stages of vegetative growth of Sinadyaya rice did not influence yield. Neither did nitrogen from ammo-phos or ammo-phos with potassium chloride.

In Pamplona, Las Piñas, (RF-20) unfertilized Guadalupe clay produced 78.9 cavans of Macan rice variety per hectare. With the split application of 40-0-0, the yield was increased to 87.9 cavans, which was not significantly higher than that of the unfertilized plot, but with the split application of 40-50-0 the yield was increased significantly. Fertilization with nitrogen from ammonium sulfate or ammo-phos before booting did not increase the yield.

The application of 20 kg. nitrogen from ammonium sulfate two weeks after planting followed by 20 kg. nitrogen from ammo-phos before booting and vice-versa made the yield of Macan rice statistically higher than than of the control. There was no response to potassium.

The same soil type in Talon (RF-19) planted also to Macan rice variety produced the highest yield only when 40 kg. nitrogen from ammo-phos was applied before booting. This was not in accordance with the previous finding that Guadalupe clay in Pamplona was benefited only by the split application of nitrogen. Applications other than before booting were ineffective. Nitrogen from ammonium sulfate added in split application or before booting or two weeks after planting followed by nitrogen from ammo-phos before booting failed to increase the yield of Macan markedly over that of the control.

In San Pedro, Guadalupe clay was benefited by 40 kg. nitrogen from ammonium sulfate applied before booting. Ramelon increased its yield from 56.7 cavans to 63.4 cavans per hectare, giving a significant difference of 6.7 cavans in favor of the nitrogen-treated plots.

TABLE 3.—*Response of lowland rice to various sources and times of application of nitrogen with or without potassium*

RATE	SOURCE	CALUMPANG CLAY			GUADALUPE CLAY			TIME OF APPLICATION
		RF-5[a]	RF-6[b]	RF-7[c]	RF-20[d]	RF-19[e]	RF-21[f]	
		yield in cavans/ha. (15% moisture)						
0– 0– 0	$(NH_4)_2SO_4$	86.6	86.3	57.0	78.9	54.5	56.7	Check
40– 0– 0		91.7	86.8	54.9				2 weeks after planting
40–50– 0	Ammo-phos	83.6	89.0	61.1				ditto
40– 0– 0	$(NH_4)_2SO_4$	89.4	100.8	66.9				6-7 weeks after planting
40–50– 0	Ammo-phos	85.1	93.3	64.4				ditto
40– 0– 0	$(NH_4)_2SO_4$	86.3	96.5	63.8	87.9	54.2	61.8	Split (2-7)
40–50– 0	Ammo-phos	84.6	92.8	68.1	88.5	59.0	61.7	ditto
40– 0– 0	$(NH_4)_2SO_4$				83.4		63.4	Before booting
40–50– 0	Ammo-phos				81.3	66.1	66.2	ditto
20– 0– 0	$(NH_4)_2SO_4$ + ammo-phos				95.6	59.2	62.9	2 weeks after planting +
20–25– 0								7 weeks before planting
20–25– 0	$(NH_4)_2SO_4$ + ammo-phos				95.6	61.1	62.7	ditto
20– 0– 0								
40–50–60	Ammo-phos + KCl			57.9	85.0	59.1	66.5	ditto
SMD (T—5%)					9.22	7.70	5.52	

[a] In Hangan, Bay, Laguna, planted to Thailand.
[b] In Masiit, Calauan, Laguna, planted to Thailand.
[c] In Pulo, Sta. Rosa, Laguna, planted to Sinadyaya.
[d] In Pamplona, Las Piñas, Rizal, planted to Macan.
[e] In Talon, Las Piñas, Rizal, planted to Macan.
[f] In San Pedro, Laguna, planted to Ramelon.

The same amount of nitrogen from ammo-phos added before booting raised the yield to 66.2 cavans per hectare. The presence of phosphorus in ammo-phos and the addition of potassium with nitrogenous fertilizer did not affect the yield.

Lipa loam in Gatid, Sta. Cruz, (RF-23) which was given 30 kg. nitrogen at planting produced no grain harvest of Wagwag rice variety (table 4). This may have been due to the accelerated succulent growth and the appearance of panicles much ahead of the other plots. Consequently, pest destruction was confined to these plots.

TABLE 4.—*Response of lowland rice to various rates and times of application of nitrogen with or without phosphorus and potassium*

RATE	GATID, STA. CRUZ, LAGUNA, RF-23 (WAGWAG)	COLLEGE, LAGUNA, RF-24 (WAGWAG)	TIME OF APPLICATION
	yield in cavans/ha. (15% moisture)		
0– 0– 0	65.9	58.0	Check
30– 0– 0	no grain harvest	48.3	Early—at planting
30– 0–60	49.1		"
60– 0–60	56.2		Split
60–90–60	54.5		Split
30– 0–60	66.4		Late—7 weeks after
60– 0–60	65.0		"
60– 0– 0		43.5	Split
0–60– 0		68.0	Early
30–60– 0		42.0	Early
60–60– 0		45.8	Split
0–60–60		62.9	Early
30–60–60		37.5	"
60–60–60		47.5	Split
90–60–60		31.3	"
SMD	5% (T)— 9.57 [a] 1% (T)—13.06	5% (T)—10.06 [b]	

[a] Negative response to early application of 30 kg. N and split application of 60 kg. N; none to late application.

[b] Negative response to early application of 30 kg. N and split application of 60 kg. N; suggestive to phosphorus alone.

It is also apparent from the data that nitrogen in split application with potassium alone or with potassium and phosphorus tended to have a less deleterious effect. On the other hand, late application of nitrogen with potassium did not influence the yield of Wagwag rice variety in this area.

Parallel trend of results was also indicated by the yield of Wagwag in Lipa loam in the UP College of Agriculture and Central Experiment Station lowland farm (RF-24). The use of nonnitrogenous fertilizer was suggestive as shown by the yield of treatment 0-60-0.

There was no response to potassium in both places.

Response to fertilization of upland soils. The yield of Inintiw rice variety on upland Lipa loam in Lalakay, Los Baños, (RF-10) was not increased by 30 and 60 kg. nitrogen from ammonium sulfate or ammo-phos with or without potassium given before booting, two weeks after planting, or in split application (table 5).

TABLE 5.—*Response of upland rice to various rates, sources, and times of application of nitrogen, phosphorus, and potassium*

TREATMENT IN KG./HA.	LIPA LOAM				TIME OF APPLICATION
	RF-10[a]	RF-12[b]	RF-13[c]	RF-16[d]	
	yield in cavans/ha. (15% moisture)				
0– 0– 0	21.4	21.9	50.5	32.4	Check
30– 0– 0 $(NH_4)_2SO_4$	15.7	20.4	72.3	43.7	Before booting
30–40– 0 Ammo-phos	21.4	23.6	70.9	39.0	ditto
60– 0– 0 $(NH_4)_2SO_4$	20.0	24.3	74.9	42.2	ditto
60–80– 0 Ammo-phos	15.6	22.1	72.2	50.5	ditto
60– 0– 0	17.1	24.5	75.7	43.4	Split
60–80– 0	16.3	24.7	79.4	44.6	ditto
30– 0– 0	20.6	29.7	69.2	36.3	2 weeks after planting
30–40– 0	17.2	23.7	67.3	39.3	ditto
30– 0–60	10.6	23.9	66.6	44.0	Before booting
30–40–60	12.7	24.0	69.8	38.3	ditto
30–40– 0 + 30– 0– 0	18.0	27.4	72.8	44.3	2 weeks after planting + before booting
SMD			9.27		

[a] In Lalakay, Los Baños, Laguna, planted to Inintiw.
[b] In Sto. Tomas, Batangas, planted to Kinanda.
[c] In Banay-banay, Lipa City, planted to Kinanda.
[d] In Sto. Tomas, Batangas, planted to Dinit-an.

Lipa loam in Sto. Tomas, Batangas, did not show any response to fertilization as indicated by the yields of both Kinanda (RF-12) and Dinit-an (RF-16) rice varieties. The various rates, sources, and times of application of nitrogen, phosphorus, and potassium did not statistically increase the yields over that of the control.

However, Lipa loam in Banay-banay, Lipa City, (RF-13) was very much improved by fertilization. Application of 30 kg. nitrogen from ammonium sulfate or ammo-phos before booting increased the yield of Kinanda rice variety from 50.5 (control) to 72.3 and 70.9 cavans per hectare, respectively. The trend of results shows that 60 kg. nitrogen from ammonium sulfate or ammo-phos given before booting or in split application is only as efficient as 30 kg. nitrogen. Application of 30 kg. nitrogen two weeks after planting tended to decrease the yield, which, however, was not significantly lower than the yields of the other treated plots.

Fertilization augmented the yield of Kinanda rice variety on upland Lipa loam in Maquiling, Calamba (table 6). Increase in yield was closely associated with the rates of nitrogen applied split. Significant increase, however, was obtained only at the 60 kg. nitrogen rate. The yield from the plots treated with 90-0-0 was not statistically higher than that of the plots treated with 60-0-0.

TABLE 6.—*Response of upland rice to various rates and times of application of nitrogen with or without phosphorus and potassium*

RATE	RF-11[a]	RF-14[b]	RF-15[c]	TIME OF APPLICATION
	yield in cavans/ha. (15% moisture)			
0– 0– 0	38.3	25.5	31.9	Check
30– 0– 0	43.3	35.1	39.2	Split ⅓, ⅔
60– 0– 0	49.3	42.1	35.5	ditto
90– 0– 0	52.6	48.8	45.2	ditto
60–90– 0	52.6	43.1	52.8	ditto
90–90– 0	51.9	51.6	58.4	ditto
60–90–90	53.2	48.2	52.9	ditto
90–90–90	60.8	54.6	49.1	ditto
60–75– 0	50.5	48.7	51.5	ditto
30– 0– 0	52.6	39.2	28.4	At planting
30– 0– 0	40.4	33.1	35.5	At booting
60–25– 5	54.2	42.8	48.9	Split ⅓, ⅔
SMD (T—5%)	8.3	7.82	10.7	

[a] Lipa loam in Maquiling, Calamba, planted to Kinanda.
[b] Ibaan loam in Pinagtungulan, Lipa City, planted to Dumali.
[c] Guadalupe clay in Muntinlupa planted to Kinanpupoy.

There was no response to phosphorus with 60 kg. and 90 kg. nitrogen. The use of potassium was suggestive but not consistent. Plots given treatment 90-90-0 produced 51.9 cavans, whereas those given 90-90-90 produced 60.8 cavans. On the other hand, plots given treatment 60-90-0 yielded as much as plots given 60-90-90.

TABLE 7.—*Chemical properties of soils and response to fertilization*

CHEMICAL PROPERTIES OF SOILS				SOIL TYPE	LOCATION	RICE VARIETY	IRRIGATION	RESPONSE
pH	% O.M.	PPM P	m.e./100 g. K					
Lowland								
6.5	3.9	28.2	1.47	Calumpang clay	Tabon, Bay	Guinangang	Good	None
6.0	3.3	51.5		"	Calauan	"	"	20 kg. N split
6.4	4.3	34.0		"	Hangan, Bay	Thailand	"	None
6.2	3.4	51.3		"	Masiit, Calauan	"	"	None
6.3	1.7	3.0		Guadalupe clay	Pamplona, Las Piñas	Macan	Rain	40 kg. N from ammophos split
5.4	2.3	2.1	0.17	"	Talon, Las Piñas	Macan	"	40 kg. N from ammophos before booting
6.5	3.1	28.2	0.92	"	Pulo, Sta. Rosa	Sinadyaya	"	None
6.4	2.2	15.6		"	San Pedro, Laguna	Ramelon	"	40 kg. N before booting
5.1	2.5	0.3	0.48	Clay	Mayao, Lucena	Mangasa	Fair	None
5.8	3.5	8.3	0.77	Lipa loam	Lalakay, Los Baños	Dinurado	"	None
6.3	2.8	48.4	1.47	Lipa loam	Mabolo, Calamba	Sinan Antonio	Good	None

TABLE 7.—(continued)

CHEMICAL PROPERTIES OF SOILS				SOIL TYPE	LOCATION	RICE VARIETY	IRRIGATION	RESPONSE
pH	% O.M.	PPM P	m.e./100 g. K					
6.3	2.2	137.1	0.32	Lipa loam	Gatid, Sta. Cruz	Wagwag	Good	Negative to early application
5.8	3.4	105		" "	College	"	"	ditto
Upland								
6.2	1.4	17.0	0.60	" "	Sto. Tomas, Batangas	Kinanda	None	None
5.7	1.2	8.3	0.40	" "	Banay-banay, Lipa City	"	"	30 kg. N
5.6	1.7	26.6	1.68	" "	Maquiling, Calamba	"	"	30 kg. N at planting
6.2	1.7	100.6	0.73	" "	Lalakay, Los Baños	Inintiw	"	None
5.9	2.7	49.5	1.22	" "	Sto. Tomas, Batangas	Dinit-an	"	None
5.9	1.1	7.3	0.17	Ibaan loam	Pinagtungulan, Lipa City	Dumali	"	30 kg. N split or at planting
5.7	2.1	1.3	0.89	Guadalupe clay	Muntinlupa, Rizal	Kinanpupoy	"	60 kg. N split + 25 kg. P_2O_5

The data showed further that the addition of 30 kg. nitrogen at planting produced as much as 60 kg. nitrogen applied split, from which it may be concluded that the addition of 30 kg. nitrogen at planting may be recommended for other soils having practically identical fertility for growing Kinanda rice variety.

Ibaan loam (RF-14) in Pinagtungulan, Lipa City, significantly increased its yield of Dumali rice variety upon application of nitrogen. The yield tended to increase as the amount of nitrogen was increased. This was further supported by data from the plots given treatments containing phosphorus and potassium.

There was no response to either phosphorus or potassium. The yields of Dumali rice fertilized with N-P or N-P-K did not differ significantly from those given corresponding N treatments.

Guadalupe clay in Muntinlupa, Rizal, (RF-15) increased its yield of Kinanpupoy only when 90 kg. nitrogen was applied split, i.e., one-third at planting and two-thirds at booting. Lower rates given in a similar manner failed to increase the yield.

Guadalupe clay was highly responsive to nitrogen with phosphorus. The yield of Kinanpupoy at treatment 90-0-0 was only 45.2 cavans, whereas at 90-90-0 it was 58.4 cavans. Also, the yield of plots given the 60-90-0 treatments was 17.3 cavans higher than that of plots given 60-0-0. On the other hand, plots given treatments 60-90-90 and 90-90-90 produced only as much as their corresponding N-P plots, indicating that there was no need for potassium.

It may be further noted that the yield of Kinanpupoy was also associated with the amount of phosphorus applied with nitrogen. For optimum fertilizer usage the 60-25-0 treatment may be recommended.

Chemical properties of soils and response to fertilization. Soil reaction ranged from pH 5.1 to pH 6.5 (table 7). Rola and Galvez reported that pH range of 5.5 to 6.7 was optimum for growing rice.[2] Since the soil pH range found was close to the finding of Rola and Galvez, soil reaction could not have been the critical factor in the present work.

The response of Guinangang rice variety to fertilization was related to the amount of organic matter but not to the phosphorus content of Calumpang clay. At a level of 3.3 per cent organic matter, application of 20 kg. nitrogen was essential. At 3.9 per cent,

[2] Nena A. Rola and N. L. Galvez, *Philippine Agriculturist*, 33, 120 (1945).

nitrogen fertilizer was not needed. The data showed also that 28.2 to 51.5 ppm. phosphorus was sufficient to supply the phosphorus requirement of Guinangang rice.

The response of Thailand rice variety, which was also grown in Calumpang clay, showed that the amounts of 3.4 to 4.3 per cent organic matter and 34.5 to 51.3 ppm. phosphorus were enough sources of its nitrogen and phosphorus needs.

The response of Macan rice variety highly suggests that the amounts of 1.7 to 2.3 per cent organic matter and 2.1 to 3.0 ppm. phosphorus in Guadalupe clay were too low to furnish its nitrogen and phosphorus requirements. It may also be seen that 0.17 m.e. potassium per 100 grams soil seemed adequate for the normal nutrition of this rice variety.

As shown by the response of Sinadyaya rice variety to fertilization, Guadalupe clay containing 3.1 per cent organic matter and 28.2 ppm. phosphorus did not require fertilization.

Ramelon rice variety on Guadalupe clay having 2.2 per cent organic matter and 15.6 ppm. phosphorus required the application of 40 kg. nitrogen, indicating that 2.2 per cent organic matter could not supply its need of nitrogen but that 15.6 ppm. phosphorus was enough to make Ramelon grow normally.

In spite of the comparatively low organic matter and phosphorus contents of clay in Mayao, Mangasa rice variety was not responsive to the addition of fertilizers. The soil contained 2.5 per cent organic matter and only 0.3 ppm. phosphorus. In this connection, it may be mentioned that submerging rice fields in water increases the concentration of soluble iron. Extract of soils from lowland fields continuously submerged contains 4,108 ppm. iron, and that of fields intermittently submerged, only 1,697 ppm. If the iron whose concentration was increased by the submergence of soil in water was the same iron that fixed the phosphorus content of soils, the concentration of available phosphorus may have also been increased. This hypothesis may account for the nonresponsive reaction of Mayao clay to phosphatic fertilizer under lowland conditions.

Results from Lipa loam which contained as low as 2.2 per cent organic matter and 8.3 ppm. phosphorus suggest that the use of nitrogenous and phosphatic fertilizers was not required. Early ap-

plication of nitrogen reduced the yield of Wagwag rice. Other rice varieties, like Dinurado and Sinan Antonio, were sufficiently provided with nitrogen and phosphorus by Lipa loam.

In upland Lipa loam, the response of Kinanda rice variety was not consistently associated with the organic matter content of the soil. In one instance, 1.4 per cent organic matter in the soil was enough source of nitrogen for Kinanda rice, but in another, 1.7 per cent was not sufficient to supply its nitrogen requirement. The amount of 8.3 to 10.6 ppm. available phosphorus was enough for the needs of Kinanda.

The nitrogen and phosphorus requirements of Inintiw and Dinit-an were adequately furnished by 1.7 per cent and 2.7 per cent organic matter and 49.5 to 100.5 ppm. phosphorus, respectively, in Lipa loam.

Dumali rice variety grown in Ibaan loam containing only 1.1 per cent organic matter responded to the application of 30 kg. nitrogen but not to potassium even though the soil contained only 0.17 m.e. potassium per 100 grams.

According to the performance of Kinanpupoy rice variety, Guadalupe clay which contained 3.1 per cent organic matter and 1.3 ppm. available phosphorus very badly needed nitrogen with phosphorus to make farming profitable.

RECOMMENDATIONS

In view of the fact that a number of factors that increase rice yield could not be measured under the conditions of the present study, more intensive work on rice fertilization in relation to soil series, rice varieties resistant to lodging, and pests and diseases should be undertaken. This should also include studies on the chemical composition of irrigation water, nitrogen content of algae which abound in lowland fields, and depth of mud. Appropriate measures to control pests, diseases, and weeds should be employed too.

EFFECTS OF CONTINUOUS AND DISCONTINUOUS SUBMERGENCE ON RICE LODGING AND YIELD [1]

A. P. Aglibut and Paul R. Hoff

Continuous submergence produced the least lodging of Mangasa, Thailand, and Milfor 6-2, whereas submergence during the first and last stages of growth and development produced the highest. No case of lodging on account of poor root anchorage was observed.

The three varieties varied significantly in their lodging characteristics. The percentage of lodging was least in Milfor 6-2 and highest in Thailand.

Among the blocks or replications, the second had higher lodging than any of the three blocks, which gave practically the same lodging. No significant interactions were obtained between block and treatment and between variety and treatment.

The irrigation treatments produced no significant differences in yield in the same variety. However, the three varieties produced significant differences in yield; Milfor 6-2 surpassed Thailand and Mangasa, which produced identical yields. Block II produced the highest mean yield of the three varieties, followed by block I, block III, and block IV in the order given. Interaction between block and irrigation treatment produced from significant to highly significant variations in yield. There was slight interaction between variety and treatment.

Milfor 6-2 gave +0.469 correlation coefficient between lodging and yield, the highest obtained, when the paddies were kept moist continuously during the irrigation period. A high negative correlation coefficient of −0.783 was obtained from the same variety when submergence irrigation was applied in the next 30 days from two weeks after transplanting. In Thailand, positive correlations of 0.641, 0.595, and 0.722 were obtained with irrigation treatments 4, 7, and 8, respectively. Lodging of Mangasa was not closely associated with weight of head or yield.

There was no positive relationship between lodging and height in Milfor 6-2 and Thailand. In Mangasa, however, lodging was highly associated with height.

Rice plants may lodge at the preheading, heading, or maturing stage. At whichever stage, decrease in the yield of grain results. Umali, Castillo, and Castillo [2] reported these reductions in yield of Milfor 6-2 due to lodging: 80.9 per cent if the plants lodge two weeks

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[1] Central Experiment Station Contribution No. 1866. Read at the 6th FAO Meeting of the International Rice Commission's Working Party held in Penang, Malaya, from December 5 to 11, 1955.

[2] Dioscoro L. Umali, E. S. Castillo, and P. S. Castillo, "The Influence on the Time of Lodging to Yield and Other Agronomic Characteristics of Three Varieties of Rice." (Unpublished manuscript, 1950.)

before heading, 43.2 per cent at heading time, 22.9 per cent one week after heading, and 9.0 per cent two weeks after heading.

Several causes of rice lodging have been mentioned. It is considered a varietal characteristic as can be seen from the unequal lodging tendencies and behavior of different rice varieties subjected to the same conditions of growth. Strong winds, heavy rains, and other environmental conditions cause different degrees of bending and reclining of plants of the same variety. Also, the taller the plants the more they lodge. Fully developed and heavy heads or panicles also cause lower reclining of the plant, and it is commonly, but erroneously, believed locally that lodging of rice is associated with high yield.

Grist [3] cited Walton and Morris as concluding that "in rich soil the chain of sequence appears to be hyper-nutrition, low carbon-nitrogen relation, a preponderance of vegetative growth, and consequent straw weakness. On poor soils the reverse is true—a high carbohydrate-nitrogen relation, a reduction in the proportion of vegetative growth and straw strength." Grist also mentioned that such external factors as shading, hyper- and unbalanced nutrition, temperature, and disease are responsible for lodging.

It was held possible that lodging may also be affected by water management. A study of the effects of continuous and discontinuous submergence on rice lodging and yield was therefore undertaken in the lowland rice farm of the Central Experiment Station during the dry season from December, 1954, to May, 1955.

MATERIALS AND METHODS

Preparation of the paddies. The experimental field was submerged continuously in water for three days before plowing. After plowing, it was again submerged for one week before it was harrowed. Two rows of 16 plots or paddies each were laid out, each paddy measuring 5 meters in width and 8 meters in length. Earth dikes, ½ meter wide, were built and compacted and made high enough between the paddies to prevent the flow of water from one paddy to another. A common irrigation ditch between the two rows of paddies and a drainage ditch along each outer side of the paddies were constructed.

Varieties of rice planted. Three local varieties of lowland rice that vary only slightly in their period of maturity but are known to

[3] D. H. Grist, "Rice," Longmans, Green and Co., London, 1955, 333 pp.

vary widely in lodging tendencies were selected as indicators in this study. Variety (a) Milfor 6-2 is reputed to be resistant to lodging, (b) Thailand, a medium lodger, and (c) Mangasa, a good lodger.

The seedlings were 15 days old when they were transplanted on December 23, 1954. They were planted in every paddy in straight rows 30 centimeters apart and 20 centimeters between hills in the row. Identical numbers of seedlings were planted in the hills, 36 hills in every row and 13 rows in every paddy. There were three rows of the middle variety and five rows each of the outside varieties in the paddies. The varieties were randomized as to irrigation treatment for the second, third, and fourth replications. The two outside rows of every paddy and the two hills in each end of every experimental row were excluded in the determination of the percentage of lodging and yield.

Irrigation treatments. Eight irrigation treatments were used which were based on the stages of growth and development of the rice plant. These stages were called for convenience as follows:

A—A period of 30 days, reckoned from two weeks after transplanting.

B—From 44 days after transplanting to flowering stage.

C—From flowering to harvest time.

From three days after transplanting through 11 days later, all the paddies were given uniform light irrigations primarily for the establishment of the seedlings. The depth of irrigation used for submergence during the stages of growth and development specified in the irrigation schedule was kept at about 5 centimeters. The paddies that were to be kept moist were given very light but frequent watering. Below is shown the eight irrigation treatments and stages of plant growth during which submergence and moist-to-saturating irrigations were applied in block I:

IRRIGATION TREATMENT NUMBER	STAGE OF PLANT GROWTH AND DEVELOPMENT WHEN SURFACE OF PADDY WAS KEPT	
	Submerged	Moist to saturated
1	A	B, C
2	B	A, C
3	C	A, B
4	A, B	C
5	B, C	A
6	A, C	B
7	A, B, C	—
8	—	A, B, C

The complete irrigation schedule followed during the experiment for the four replications or blocks was of the split-plot design. The irrigation treatments were the whole plots and the three varieties were split plots, the relative positions of which were randomized in the different paddies.

Fertilization and weeding. For the purpose of raising the general fertility level of the paddies, they were fertilized with equal amounts of complete fertilizer, 13-13-13, at the rate of 150 kilograms per hectare, 600 grams for each paddy, on the recommendation of the Department of Soils. The fertilizer was broadcast 12 days after transplanting.

The paddies were weeded entirely by hand. Those that were submerged continuously, treatment 7, had fewer weeds and were weeded two times only. Those that were submerged intermittently had to be weeded four times from transplanting to booting. Six weedings were necessary for good weed control in the paddies that were kept continuously moist, treatment 8.

Pest and disease control. In this study no evidence of serious rice disease was noted. On January 22, 1955, some army worms, probably *Spodoptera mauritia* Bond,[4] were detected. All the paddies were sprayed with good results using 25 per cent DDT in Gesarol at a concentration of one tablespoonful in one gallon of water. Spraying was at a pressure of about 40 pounds per square inch for good atomization. For stem borer control all the rice plants were sprayed with Endrin at a concentration of 5 ml. in one gallon of water on February 5, February 24, and March 17, 1955. On March 25, 1955, some soldier bugs, *Nezara viridula Linn.*,[5] were detected feeding on the panicles of the Thailand variety which was then in the milk stage. Bladex spray, 10 ml. in one gallon of water concentration, was used very carefully and produced a deadly effect.

RESULTS AND DISCUSSION

Lodging as affected by irrigation. The lodged bearing tillers in eight hills randomly selected in every experimental row of the three varieties were counted. A tiller was considered lodged if it reclined at an angle more than 45° from the vertical position. The percentage of lodging in a hill was obtained by dividing the lodged

[4] Identified by Dr. George Matthysse, Cornell Visiting Professor of Entomology, who also recommended the spray.

[5] Identified by Dr. Getulio B. Viado, Research Associate Professor of Entomology, who also recommended the spray.

tillers by the total number of bearing tillers in the hill and multiplying the quotient by 100. The mean and total percentages of lodging by row and by variety in every block were then determined.

It was observed that natural lodging in the three varieties took place soon after flowering. Mangasa began to lodge in less than a week after flowering, and Thailand, about one week later. Milfor 6-2 began to lodge lightly at about the maturity stage and continued moderately until harvest time.

Mangasa matured in 112 to 126 days after sowing. Thailand matured in 120 to 126 days and Milfor 6-2, in 134 to 138 days.

The irrigation schedule used in the study produced significant effects on lodging (table 1). The calculations were made in angles into which the percentages of lodging were transformed (Snedecor, 1946).[6] Of the eight irrigation treatments, continuous submergence, treatment 7, gave the lowest lodging and treatment 6, the highest. This result is not in complete agreement with Copeland's finding that "continuous submergence predisposes to lodging, by interfering with the development of the mechanical tissues of the culm and stimulating its growth." [7]

A possible explanation for the disagreement is that the depth of submergence of about 5 centimeters used in this study was not too much to affect adversely the development of the mechanical tissues of the culms and the growth of roots especially in the aerobic layer of the soil in the continuously submerged paddies. Since no case of lodging on account of poor root anchorage was observed in the paddies that were continuously submerged, it can be said that there was good growth and spread of roots.

Also, a study of the depth of the experimental paddies revealed that the surface soil of the paddies that were continuously submerged was not very deep. Without much fertilization, it would not and did not produce excessive vegetative growth. The absence of significant positive correlations between height and lodging of Milfor 6-2 and Thailand in all irrigation treatments shows that continuous submergence does not necessarily produce lodging.

The three rice varieties used as indicators varied in their lodging characteristics very significantly. Milfor 6-2 lodged the least and,

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[6] G. W. Snedecor, "Statistical Methods," Iowa State College Press, 1946, 4th ed.

[7] Edwin Bingham Copeland, "Rice," Macmillan and Co., Limited, London, 1924, 352 pp.

surprisingly, Thailand lodged more than Mangasa. It was observed also that Mangasa reclined the greatest, Thailand less than Mangasa, and Milfor 6-2 the least.

Among the four blocks or replications, the second produced significantly higher lodging than the others, which gave practically the same results. There seemed to be no significant interactions between treatment (T) and block (B) and between variety (V) and treatment (T).

Yield as affected by irrigation. The same depth of irrigation, about 5 centimeters, applied either continuously or intermittently, did not produce significant differences in yield (table 2). Also, the paddies which were kept in a moist-to-saturated condition during the observation period produced as much as those given submerging irrigations. However, the three varieties showed highly significant differences in yield. Milfor 6-2, the most resistant to lodging, surpassed easily the Thailand and Mangasa varieties, which produced identical yields.

Examination of block or replication as a source of variation in yield among the three varieties showed a significant variation among the paddies. Block II produced the highest mean of 2,034.40 grams for the three varieties, followed by block I, block III, and block IV in the order named. Later survey of the paddies by some personnel of the Department of Soils showed that there was a slight variation in the average depth of the surface soil of the paddies where the four replications were located. The paddies included in block II had an average depth of above 13 inches, and the others, about 12 inches.

The effect of the interaction between block (B) and irrigation treatment (T) varied from significant to highly significant. There appeared to be slight interaction between treatment (T) and variety (V).

Correlation between lodging and yield of grain. To see if there was any relation between lodging and yield of grain, correlation coefficients were calculated for each variety. The highest correlation coefficient, +0.469, was obtained for Milfor 6-2 when the paddies were kept moist continuously during the period of observation (treatment 8). A high negative correlation coefficient, −0.783, was obtained for the same variety when submergence irrigation was applied during the first stage of plant growth following transplanting (treatment 1). For the other irrigation treatments, the coefficients

of correlation were low, either positive or negative, showing no direct relationship between lodging and yield. These figures show that in Milfor 6-2 there existed little degree of association between lodging and yield. Therefore, lodging of Milfor 6-2 may be said to be a varietal characteristic that may not be caused much by weight of head.

In the case of Thailand, coefficients of correlation of +0.641, +0.595, and +0.722 were obtained respectively from paddies which were submerged during the first two stages (A and B) of plant growth (treatment 4), submerged continuously during the irrigation period (treatment 7), and kept moist to saturated continuously (treatment 8). In the other treatments there was no correlation between lodging and weight of head or yield.

Similarly, lodging of Mangasa was not influenced by the weight of grain. The highest but negative correlation, −0.540, was obtained in treatment 6.

Correlation between lodging and height of plant. In Milfor 6-2 all but one of the computed coefficients of correlation were negative, and the two highest, −0.423 and −0.479, were obtained from treatments 4 and 5, respectively. These figures show some indirect association between lodging and height of Thailand rice plants that were irrigated. A negative correlation coefficient, −0.547, was obtained from paddies that were kept moist continuously. This shows also that the short plants lodged just as much, if not more, than the tall plants.

In Mangasa, higher coefficients than those found in the first two varieties were obtained in the last seven treatments. These were +0.942, +0.360, +0.772, +0.550, +0.606, +0.866, and +0.581 for the respective irrigation treatments 2, 3, 4, 5, 6, 7, and 8. It can be said that Mangasa lodged more as the plants grew taller.

Weather observations. The weather observations are shown in table 3. The period covered was from December, 1954, to May, 1955. A total rainfall of 527.2 millimeters occurred in 72 days, most of it falling in the months of December, before transplanting the seedlings, January, and May after harvesting the crop.

The temperature ranged from 20.9°C. to 32.7°C. during the growth of the rice plants, and the average relative humidity was 77.4 per cent. There were 37.2 cloudy days during the period, with a monthly average of 6.2 cloudy days.

TABLE 1.—*Percentage of lodging of three rice varieties given different irrigation treatments*

BLOCK	VARIETY	IRRIGATION TREATMENT NUMBER								TOTAL
		1	2	3	4	5	6	7	8	
I	a	18.81	16.30	11.83	14.42	10.78	17.85	11.83	10.63	112.47
	b	63.44	59.28	58.18	51.71	46.26	90.00	61.68	90.00	520.55
	c	74.11	73.89	39.35	37.70	63.94	65.27	46.61	69.47	470.34
II	a	8.91	13.56	10.63	0	4.80	10.78	0	0	48.68
	b	90.00	90.00	90.00	82.96	74.00	90.00	90.00	90.00	696.96
	c	76.31	72.95	45.06	90.00	75.11	66.03	90.00	90.00	605.46
III	a	6.29	12.66	7.27	8.13	—	2.56	0	3.14	40.05
	b	90.00	61.34	53.97	90.00	54.70	90.00	56.23	90.00	586.24
	c	70.54	46.89	51.12	73.36	41.44	46.38	48.85	42.30	420.88
IV	a	23.11	16.43	3.63	0	0	10.47	22.30	6.55	82.49
	b	90.00	90.00	90.00	0	90.00	90.00	0	0	450.00
	c	18.15	90.00	80.90	90.00	76.56	86.66	75.11	90.00	607.38
Total		629.67	643.32	541.94	538.28	537.59	666.00	502.61	582.09	4,641.50
Average for treatment		52.47	53.61	45.16	44.86	48.87	55.50	41.88	48.51	

Analysis of variance

SV	DF	SS	MS	COMPUTED F-VALUE
Treatment (T)	7	4,260.55	608.65	5.82 [a]
Block (B)	3	4,189.21	1,396.40	13.34 [b]
T × B	21	2,197.33	104.63	0.17 [c]
Variety (V)	2	75,180.11	37,590.05	60.73 [b]
T × V	14	2,028.32	126.77	0.20 [c]
Pooled error	47 [d]	28,471.39	618.94	
Total	94	112,137.70		

SV		$\bar{x}$	SMD 5%	SMD 1%	SV		$\bar{x}$	SMD 5%	SMD 1%
Treatment	1	52.47	8.76	11.92	Block	1	45.97	6.14	8.35
	2	53.61				2	56.30		
	3	45.16				3	45.52		
	4	44.86				4	47.49		
	5	48.87							
	6	55.50							
	7	41.88							
	8	48.51							
Variety	a	9.15	12.53	16.73					
	b	70.43							
	c	65.75							

[a] Significant.
[b] Highly significant.
[c] Not significant.
[d] Less one d. f. for missing data.

TABLE 2.—*Yield in grams of grain at 14 per cent moisture from three rows each of three varieties given different irrigation treatments*

BLOCK	VARIETY	IRRIGATION TREATMENT NUMBER								TOTAL
		1	2	3	4	5	6	7	8	
I	a	2,411.7	2,273.6	1,894.1	2,282.5	2,507.6	2,026.5	2,646.4	2,636.0	18,678.4
	b	1,489.4	1,617.7	1,384.8	1,940.8	1,750.2	1,510.4	1,997.5	1,566.0	13,256.8
	c	1,594.2	2,024.5	1,186.6	1,595.8	1,752.5	1,300.2	1,974.8	1,293.1	12,721.7
										44,656.9
II	a	2,506.3	2,419.9	2,330.8	3,148.3	2,664.0	2,713.1	2,443.5	2,626.5	20,852.4
	b	1,364.5	1,963.3	1,582.4	2,190.1	1,927.6	1,019.9	1,714.3	1,459.4	13,221.5
	c	1,705.9	2,478.9	1,938.1	1,875.1	2,112.0	1,269.2	1,997.6	1,375.0	14,751.8
										48,825.7
III	a	2,686.5	2,240.7	2,008.7	2,248.4	—	1,988.0	2,198.1	2,475.9	15,846.3
	b	1,557.9	1,991.6	1,669.3	1,430.6	1,284.8	1,355.1	2,373.1	1,167.8	12,825.2
	c	2,003.9	1,730.9	1,430.0	1,063.3	1,364.0	2,650.3	1,787.2	1,328.5	13,358.1
										42,029.6
IV	a	2,235.9	2,654.4	2,581.7	2,402.8	2,733.2	2,561.3	1,982.4	2,481.7	19,633.4
	b	1,691.8	1,429.0	1,499.0	417.9	949.5	977.8	1,174.2	719.3	8,859.0
	c	1,657.2	1,725.2	1,279.3	921.1	1,288.8	1,699.0	723.9	1,072.9	10,367.4
										38,859.8
Total		22,900.2	24,549.7	20,784.8	21,516.7	20,334.2	21,070.8	23,013.5	20,202.1	174,372.0
Average for treatment		1,908.35	2,045.81	1,732.07	1,793.06	1,848.56	1,755.90	1,917.79	1,683.51	

S.E. (treatment) = 128.72

Analysis of variance

SV	DF	SS	MS	COMPUTED F-VALUE
Treatment (T)	7	1,180,829.4	168,689.9	0.85 [a]
Block (B)	3	2,089,562.8	696,520.9	3.50 [b]
B × T	21	4,175,155.8	198,816.9	2.40 [b]
Varieties (V)	2	15,848,659.9	7,924,329.9	95.59 [c]
T × V	14	2,126,091.5	151,863.7	1.83 [a]
Pooled error	47 [d]	3,896,051.3	82,894.7	
Total	94	29,316,350.7		

SV		$\bar{x}$	SMD 5%	SMD 1%
Block	I	1,860.70		
	II	2,034.40	84.66	
	III	1,751.23		
	IV	1,619.16		
Varieties	(a)	2,419.69		
	(b)	1,505.08	145.87	194.30
	(c)	1,599.90		

SV		$\bar{x}$		$\bar{x}$	SMD 5%	SMD 1%
B × T	I	1,831.8	I	2,003.4		
	II	1,858.9	II	2,234.5		
	III	2,081.1	III	1,324.4		
	IV	1,861.6	IV	1,657.2		
	I	1,971.9	I	1,612.4		
	II	2,287.3	II	1,667.4		
	III	1,987.7	III	1,997.8		
	IV	1,936.2	IV	1,746.0		
					472.74	630.95
	I	1,488.5	I	2,206.2		
	II	1,950.4	II	2,051.8		
	III	1,702.7	II	2,119.5		
	IV	1,786.7	IV	1,293.7		
	I	1,939.7	I	1,831.7		
	II	2,404.5	II	1,820.3		
	III	1,580.7	III	1,657.4		
	IV	1,247.3	IV	1,424.6		

[a] Not significant.
[b] Significant.
[c] Highly significant.
[d] Less one d. f. for missing data.

TABLE 3.—*Weather observations from sowing to harvesting of the rice plants*

MONTH	TEMPERATURE		MEAN RELATIVE HUMIDITY	RAINFALL		CLOUDINESS [a]
	Minimum	Maximum		Total	Distribution	
	°C.	°C.	*per cent*	*mm.*	*days*	*days*
December, 1954 [a]	21.9	27.7	87.2 [b]	184.2	23	7.8
January, 1955 [a]	21.7	27.9	87.4 [b]	129.3	18	7.3
February, 1955 [a]	20.9	30.2	69.1 [b]	3.6	5	6.5
March, 1955 [c]	21.6	29.8	74.4 [d]	7.9	6	4.2
April, 1955 [c]	23.8	31.6	73.8 [d]	76.2	8	5.7
May, 1955 [c]	24.3	32.7	72.6 [d]	126.0	12	5.7
Total	134.2	179.9	464.5	527.2	72	37.2
Mean	22.4	30.0	77.4	87.9	12	6.2

[a] Data obtained from the weather station at the College Campus, College of Agriculture, College, Laguna.

[b] Data obtained from the average of daily readings from 8:00 a.m. to 5:00 p.m.

[c] Data obtained from the weather station at the lowland rice experiment station, College of Agriculture, College, Laguna.

[d] Data obtained from the average of 8 readings during the 24-hour period.

Outside his profession, . . . the scientist is no paragon of selfless virtue and wisdom, and within it he will cherish his brain child, hold out for his own theory as long as the facts permit. Yet the scientific community as a whole is the most impressive example history has yet known of a disinterested, cooperative enterprise, international in scope, directed toward impersonal ends and by impersonal standards. It is the most impressive demonstration of the actual possibility of "supra-personal, supra-partisan, supra-racial standards and values."—*Herbert J. Muller*

THREE ORGANIC INSECTICIDES IN THE CONTROL OF INSECTS AFFECTING UPLAND RICE [1]

CELESTINO T. RIVERA

Parathion, TEPP, and toxaphene were tested as sprays against the rice stem borer, *Schoenobius incertulas* Walker, the rice leaf folder, *Cnaphalocrosis medinalis* Gueneé, and the rice bug *Leptocorisa acuta* Thunberg. In both the three-spray and six-spray schedules, parathion, TEPP, and toxaphene were significantly effective in reducing the insect infestations in the field. In the laboratory, parathion, followed by TEPP, was effective against rice bug and the larvae of rice leaf folder and rice stem borer; toxaphene was not significantly effective. Not one of the three organic insecticides showed adverse effect on the leaves, stems, and panicles of the rice plants.

Before 1954, insecticides for the control of insects affecting rice were not extensively used in the Philippines, probably because of the absence of suitable ones. Some of the new insecticides, notably the organic phosphates, are reported to have been used successfully in other countries for the control of rice insects, particularly the stem borer. These insecticides may also prove effective against rice pests in this country.

To determine the effect of three insecticides on some insects affecting upland rice and on the rice plants, this study was conducted from April, 1954, to January, 1955, in the Department of Entomology and in the experimental field of the Department of Agronomy.

MATERIALS AND METHODS

The organic insecticides tested were commercially formulated preparations used as received from the Shell Co. of the Philippines, Ltd., and the Philippine Factors, Inc. They were (1) TEPP in the form of Bladex, a 20 per cent emulsifiable concentrate, (2) parathion, a 46.7 per cent emulsifiable concentrate in the form of Folidol E605, and (3) toxaphene, a 60 per cent emulsifiable concentrate in the form

[1] Central Experiment Station Contribution No. 1867. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, March, 1955. Prepared in the Department of Entomology under the direction of Associate Professor Getulio B. Viado.

of Resitoxaphene. Bladex was used at the rate of 9.5 cc. to a gallon of tap water, Folidol at 4.04 cc., and Resitoxaphene at 3.2 cc. They were sprayed with a two-gallon compressed-air sprayer operated between 20 and 40 pounds of pressure to a square inch.

The major rice insect pests considered in this investigation were the rice bug *Leptocorisa acuta* Thunberg; the rice leaf folder, *Cnaphalocrosis medinalis* Gueneé; and the yellow rice stem borer, *Schoenobius incertulas* Walker.

In a newly plowed field, plots were laid out in a replicated randomized complete block experiment. In each block, two plots were marked for Folidol spray application, two for Bladex, two for Resitoxaphene, and one for the control, which did not receive any treatment. Three plots received six applications at one-week intervals, and three plots received three at two-week intervals.

The first spray application was done on August 7, 1954, when the plants were two months old. Before the spraying, the initial insect infestation on the 10 middle rows of each plot was observed. The sprays were applied as evenly as possible on all parts of the plants at the rate of 300 gallons to a hectare. Proper precautions were taken during spraying to avoid unnecessary breaking of the stalks and other vegetative parts which might cause the plants to die. One week after the last spraying, a more careful observation was made of the intensity of damage by the three pests on the treated and untreated lots.

The palay was harvested at the age of 145 days. The following observations were made on 50 hills taken at random from each treatment: total number of sound panicles, total number of tillers attacked by rice stem borer, and total number of leaves affected by rice leaf folder.

The rice bug was the first insect used in the laboratory tests. Four panicles each in the milk stage were sprayed thoroughly with each insecticide with a hand atomizer and then placed in a cylindrical wire-screen cage. Four untreated panicles in a separate cage served as control. In each cage, 10 rice bug adults were introduced on top of the panicles. The mortality and extent of feeding were noted after 2, 12, 24, 48, and 96 hours until all the adults in the treated cages were dead. The repellent action of each insecticide on the adults was also noted.

For the test on the rice leaf folder, *Cnaphalocrosis medinalis*, 21 potted rice plants were brought to the testing room. All the plants,

except the control, were sprayed. The sprayed plants were allowed to dry before larvae of about the same size, 30 to a treatment, were placed on the plants. Records of the larvae that died after 2, 6, 12, 48, and 96 hours were kept. The repellent action of the spray materials on the larvae was also observed.

In the test on the larvae of the rice stem borer, 21 potted rice plants, each with three tillers, were used. Each tiller received only one larva. Twenty-four hours after the larvae had been placed on the tillers, the plants were sprayed and the mortality rates were taken after 24, 48, 72. 96, and 120 hours.

DISCUSSION OF RESULTS

Field tests

Herbicidal effect of insecticidal sprays. None of the materials had any apparent adverse effect on the leaves, stems, and panicles of the rice plants.

Effect on rice leaf folder. The percentages of plants with damaged leaves, stems, and panicles were transformed into angles which

TABLE 1.—*Efficacy of three organic insecticidal sprays based on the transformed angles of percentages of damaged leaves*

TREATMENT	BLOCK			TOTAL	MEAN	MEAN [a]
	I	II	III			
Control	26.21	27.06	29.06	82.33	27.44	21.2
TEPP 3×	19.91	20.88	25.84	66.63	22.21	14.3
TEPP 6×	12.39	17.85	17.05	47.29	15.76	7.4
Parathion 3×	17.36	23.89	22.22	63.47	21.14	13.0
Parathion 6×	11.97	16.64	18.05	46.66	15.33	7.2
Toxaphene 3×	20.79	25.77	22.55	69.11	23.03	15.3
Toxaphene 6×	17.46	20.70	23.97	62.13	20.71	12.5
Total	126.09	152.79	158.74	437.62		

[a] Represents original data in per cent.

Analysis of variance

SV	DF	SS	MS	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Treatment	6	312.44	52.07	19.07	3.00	4.82
Block	2	86.40	43.20	15.84	3.88	6.93
T × B	12	32.72	2.73			
Total	20	431.56				

SMD at 5% level (T) = 2.92

were statistically analyzed by the method of C.I. Bliss.[2] There was a significant decrease in the number of damaged leaves in all the treated lots when the plants were sprayed six times (table 1). Parathion and TEPP gave the lowest mean percentages of damaged leaves.

When the plants were sprayed only three times, the infestation in the parathion-treated lot was 8.2 per cent less than in the control; in the TEPP-treated lot, 6.9 per cent less; and in the toxaphene-treated lot, 5.9 per cent less. The infestation in the plots sprayed

TABLE 2.—*Efficacy of three organic insecticidal sprays based on the transformed angles of percentages of damaged stems*

TREATMENT	BLOCK			TOTAL	MEAN	MEAN [a]
	I	II	III			
Control	28.38	31.82	31.76	91.96	30.65	26.0
TEPP 3×	19.55	22.30	17.85	59.70	19.90	11.6
TEPP 6×	11.24	13.81	14.89	39.94	13.31	5.3
Parathion 3×	15.12	21.39	18.91	55.42	18.60	10.2
Parathion 6×	8.33	11.24	9.63	29.20	9.73	2.9
Toxaphene 3×	27.69	23.66	21.56	72.91	24.33	17.0
Toxaphene 6×	24.50	22.46	20.53	67.49	22.49	14.6
Total	134.81	146.68	135.13	416.62		

[a] Represents original data in per cent.

Analysis of variance

SV	DF	SS	MS	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Treatment	6	87.56	145.26	27.56	3.00	4.82
Block	2	13.07	6.53	1.24	3.88	6.93
T × B	12	63.29	5.27			
Total	20	947.92				

SMD at 5% level (T) = 4.07

six times was also significantly lower than that in the control. Parathion and TEPP gave more significant reductions of rice leaf folder damage in the six-spray schedule than in the three-spray schedule. With toxaphene, the two schedules of spraying did not significantly differ.

[2]George W. Snedecor, "Statistical Methods Applied to Experiments in Agriculture and Biology," The Iowa State College Press, Ames, Iowa, 1946, 4th ed., 485 pp.

Effect on rice stem borer. The percentages of plants with damaged stems are presented in table 2. Parathion gave the best control against rice stem borer in the lots sprayed six times. All the treatments significantly reduced borer damage. Except with toxaphene, spraying six times was significantly better than spraying three times. Parathion reduced the infestation by 24.1 per cent; TEPP, by 20.7 per cent; and toxaphene, by 11.4 per cent.

Effect on rice bug. The percentage of sound panicles was significantly higher in the treated lots than in the control (table 3). Of the insecticides, only toxaphene gave no significant difference when sprayed six times than when sprayed three times. TEPP gave the best check against the rice bug in the lots sprayed six times. It reduced the infestation by 35.1 per cent, followed by parathion, 31.0 per cent; and toxaphene, 16.7 per cent. In the lots sprayed three times, TEPP gave the highest mean percentage of sound panicles, followed by parathion and toxaphene.

TABLE 3.—*Efficacy of three organic insecticidal sprays based on the transformed angles of percentages of sound panicles*

TREATMENT	BLOCK			TOTAL	MEAN	MEAN [a]
	I	II	III			
Control	26.28	37.35	39.70	103.33	34.44	32.0
TEPP 3×	42.59	45.69	46.89	135.17	45.65	51.1
TEPP 6×	55.73	51.59	57.61	164.93	54.97	67.1
Parathion 3×	40.80	43.74	44.83	129.37	43.12	46.7
Parathion 6×	48.97	53.01	55.67	157.65	52.55	63.0
Toxaphene 3×	38.65	38.29	44.25	121.19	40.39	42.0
Toxaphene 6×	42.65	44.37	45.80	132.82	44.27	48.7
Total	295.67	314.04	334.75	944.46		

[a] Represents original data in per cent.

Analysis of variance

SV	DF	SS	MS	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Treatment	6	879.66	146.61	21.69	3.00	4.82
Block	2	109.22	54.61	8.08	3.88	6.93
T × B	12	81.09	6.76			
Total	20	1,069.97				

SMD at 5% level (T) = 4.62

Effect on yield. Based on the yield of grains in grams in the plots sprayed six times, the parathion-treated plants gave the highest percentage increase in yield, 12.94 (table 4). The increase in yield of the TEPP-treated plants was 12.06 per cent, and of the toxaphene-treated plants, 2.28 per cent.

TABLE 4.—*Effects of three organic insecticidal sprays on the yield of grains in grams based on 50 hills in each treatment*

TREATMENT	BLOCK			TOTAL	MEAN
	I	II	III		
Control	592.3	499.8	512.0	1,604.1	534.7
TEPP 3×	591.2	600.2	497.1	1,688.5	562.8
TEPP 6×	597.4	608.1	592.1	1,797.6	599.2
Parathion 3×	534.2	522.1	534.2	1,610.5	536.8
Parathion 6×	612.1	598.1	601.4	1,811.6	603.9
Toxaphene 3×	591.2	497.8	516.1	1,805.1	535.0
Toxaphene 6×	597.7	544.6	498.5	1,640.8	546.9
Total	4,116.1	3,870.7	3,771.4	11,758.2	

Analysis of variance

SV	DF	SS	MS	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Treatment	6	16,334.6	2,722.4	2.45 [a]	3.00	4.82
Block	2	8,898.3	4,494.2	4.05	3.88	6.93
T × B	12	13,171.4	1,109.5			
Total	20	38,494.3				

[a] Suggestive.

The increases in yield of the lots sprayed three times were as follows: TEPP-treated plants, 5.26 per cent; parathion-treated plants, 0.39 per cent; and toxaphene-treated plants, 0.07 per cent. These results show that better yield can be obtained by increasing the number of spray applications.

Laboratory tests

On the adult of the rice bug. Both parathion and TEPP gave a complete kill after 24 hours, but TEPP appeared to have a faster killing effect than parathion (table 5). Toxaphene had the slowest toxic effect on the insect; mortality was observed after 96 hours. None of the test insects on the control died during the test. Not enough nymphs were available for testing.

TABLE 5.—*Effects of three organic insecticidal sprays on rice bug* [a]

INSECTICIDE	NUMBER OF INDIVIDUALS	NUMBER OF ADULTS KILLED AFTER SPECIFIED NUMBER OF HOURS						REMARKS
		2	6	12	24	48	96	
TEPP	40	15	23	40				Adults fed on the treated panicles
Parathion	40	4	22	34	40			Adults fed on the treated panicles
Toxaphene	40			2	11	19	40	Adults fed on the treated panicles

[a] The rice bug adults on the control of each treatment fed heavily on the untreated leaves.

On the larva of rice leaf folder. Of the three insecticides, toxaphene was the least toxic on the larvae of rice leaf folder (table 6). A complete kill was observed with parathion after 12 hours; with TEPP, after 48 hours. All the larvae were observed to feed on the treated leaves. Not one larva on the control died during the test.

TABLE 6.—*Effects of three organic insecticidal sprays on rice leaf folder* [a]

INSECTICIDE	NUMBER OF INDIVIDUALS	NUMBER OF LARVAE KILLED AFTER SPECIFIED NUMBER OF HOURS						REMARKS
		2	6	12	24	48	96	
TEPP	40	14	21	28	32	40		Larvae fed on the treated leaves
Parathion	40	16	29	31	40			Larvae fed on the treated leaves
Toxaphene	40		4	7	19	31	40	Larvae fed on the treated leaves

[a] The rice leaf folder larvae on the control of each treatment fed heavily on the untreated leaves.

On the larva of rice stem borer. Parathion had the shortest killing time (table 7). It killed the most larvae after 48 hours. In the lot treated with TEPP, a complete kill was noted after 72 hours; in the lot treated with toxaphene, after 120 hours. The larvae attempted to feed inside the stems treated with parathion and TEPP, but they did not cause much injury to the plants because they were killed 48 hours after the treatment. In the other treatments, the larvae fed on both the treated and the untreated plants. Not one larva on the control died during the test.

TABLE 7.—*Effects of three organic insecticidal sprays on rice stem borer* [a]

INSECTICIDE	NUMBER OF INDIVIDUALS	NUMBER OF LARVAE KILLED AFTER SPECIFIED NUMBER OF HOURS					REMARKS
		24	48	72	96	120	
Parathion	15	9	15				Larvae fed inside the stem
TEPP	15	4	7	15			Larvae fed inside the stem
Toxaphene	15		2	3	6	15	Larvae fed inside the stem

[a] The rice stem borer larvae on the control of each treatment fed inside the stems.

In no other human activity [science] is a higher premium placed upon truthfulness, or is the ideal of truthfulness more fully realized. Success in science is possible only on these terms. The eminent statesman or businessman may be unscrupulous, and indeed cannot afford too many or too fine scruples; the passionate sincerity of artists and other intellectuals may still be warped by wishful preferences, and their fervor and eloquence come by more easily because of the wishfulness; but no scientist can ever hope to succeed by misrepresenting, or by remolding according to his heart's desire.

—*Herbert J. Muller*

THE INHIBITING EFFECT OF MALEIC HYDRAZIDE (MH-40) ON LAWN GRASSES[1]

S. N. Fertig and Marcos R. Vega

WITH FOUR TEXT FIGURES

A 2.0 per cent maleic hydrazide solution sprayed at the rate of 1,000 liters per hectare turned the leaves of lawn grasses brown. This was first noted four days after spraying and persisted up to the end of the experiment, that is, 48 days after spraying. The spray completely inhibited growth during that length of time.

Spraying maleic hydrazide during the summer months is not advisable.

Of the concentrations and rates of application used, 0.5 per cent maleic hydrazide at 500 li./ha. (6.25 kg./ha. or 5.56 lb./acre of MH-40 in 500 li./ha. or 53.5 gal./acre of water) looked most promising. When sprayed in November at the height of the rainy season, the lawn grasses did not need clipping until a hundred days after the treatment.

Maleic hydrazide acts as a plant growth inhibitor at certain concentrations and a herbicide at others. Moore (1950) applied concentrations of 0.05 and 0.25 per cent maleic hydrazide to 12 different species of plants. Some of the responses were loss of apical dominance, narrowing and chlorosis or development of anthocyanin in new leaves, checked root growth, and varying degrees of sterility associated with effect on tissues that were meristematic or only slightly differentiated. Crafts *et al.* (1950) reported that maleic hydrazide was particularly toxic to grass species. They further reported that it affected plants at low concentrations, producing growth abnormalities apparently acting on plant meristems. Greulach and Atchison (1950) observed that a 1 — 2000 ppm. maleic hydrazide solution inhibited mitosis and cell division in proportion to the concentration.

The dry weight of turf grasses treated with 2.4 pounds per acre and clipped 14 days after spraying was 35 grams, compared with 234 grams of the check. Six weeks after spraying, the grass in all treated plots appeared normal (Anon., 1950). Burt and Willard (1952) reported that Johnson grass appeared to recover about

[1] Central Experiment Station Contribution No. 1868.

two months after treatment at the 4 and 8 pounds per acre rates and about three months after treatment at the 12 and 24 pound rates.

Anderson *et al.* (1953), working on maintained lawns containing Kentucky blue grass, observed that maleic hydrazide delayed the formation of seed heads. De France and Hart (1954) sprayed 11-year-old turf with 5.44, 10.88, and 16.32 pounds MH-40. Their results showed that 10.88 pounds of MH-40 per acre seemed to be the optimum rate from the standpoint of maximum retardation with minimum injury and discoloration.

A 3.0 per cent concentration inhibited growth of crab grass (*Digitaria* sp.), Bermuda grass (*Cynodon dactylon*), *Panicum* sp., *Paspalum* sp., and barnyard grass (*Echinochloa* sp.) (Tullis, 1951). Laning and Freed (1952) sprayed a bent grass lawn with 2 pounds and 4 pounds of maleic hydrazide per acre in June and observed that the spray severely reduced the weight of clippings and growth of grass and caused a serious loss of green coloring.

According to Zukel (1953), an even distribution of maleic hydrazide in not less than 40 gallons of solution per acre is required to secure even inhibition.

This series of experiments was performed from June, 1953, to May, 1955, to study the inhibiting effect of maleic hydrazide on lawn grasses.

MATERIALS AND METHODS

In June, 1953, a preliminary experiment was initiated to obtain information on the action of MH-40 [2] on lawn grasses, the speed at which inhibiting action occurred, the approximate concentration required, and the symptoms produced by the grasses. A lot of 3 x 3 meters was staked off and sprayed with 0.5 per cent maleic hydrazide at the rate of 5 gal./1,000 sq. ft. (ca. 2,100 li./ha.).

With the information obtained from this experiment a more detailed study was initiated. In August, 1954, the experimental area was clipped with a power lawn mower and five different treatments were applied to it as follows: left unsprayed (control) ; sprayed with 0.25 per cent maleic hydrazide, 0.50 per cent, 1.00 per cent, and 2.00 per cent. All treatments were sprayed at 1,000 liters per hectare. Each treatment was replicated four times; each replicate had an area of 2 x 2 meters.

[2] A 40 per cent formulation of maleic hydrazide. All concentrations used were calculated on a 100 per cent basis of active ingredient.

Changes in appearance of plants were observed. The grass in each replicate of all treatments was clipped 48 days after spraying and its fresh weight recorded.

With the idea of finding out the duration of the inhibiting effect of maleic hydrazide on lawn grasses and whether maleic hydrazide would act the same when applied at different times during the year, a third experiment was set up. The experimental area was mowed with a power lawn mower on November 18, 1954. Plots of 2 x 2 meters were staked out and the following treatments applied:

TREATMENT NUMBER	CONCENTRATION OF MH		EQUIVALENT RATE IN	
	%	li./ha.	kg. MH-40/ha.	lb. MH-40/acre
I	0.5	500	6.25	5.56
II	0.25	1,000	6.25	5.56
III	1.00	500	12.50	11.12
IV	0.5	1,000	12.50	11.12
V	Untreated (check)		—	—

Sixteen plots were provided for each treatment so that yield in the form of fresh weight of mowed grass could be determined at different intervals after treatment. Yields from four replications of each treatment were taken at 40, 60, 80, and 100 days after treatment. Harvesting was done by mowing with a hand lawn mower a strip of ½ x 2 meters in the center of the plot so that the harvest represented the yield of 1 sq. meter.

Observations on color of grass blades and apparent inhibiting effect of maleic hydrazide were recorded. The duration of this experiment was from November, 1954, to March, 1955, a period of rainy months.

To determine the action of maleic hydrazide during the dry season, a fourth experiment was started on February 2, 1955. Since in previous experiments 0.5 per cent maleic hydrazide at 500 li./ha. (6.25 kg./ha. or 5.56 lb./acre of MH-40 in 500 li./ha. or 53.5 gal./acre of water) looked most promising, this concentration was used. Sixteen 2 x 8 meter plots were sprayed with this concentration. Four plots each were harvested 40, 60, 80, and 100 days after spraying. Whereas in previous experiments a one-nozzle knapsack sprayer was used, in this experiment a two-meter hand boom attached to a small motor-driven pump was used to deliver the solution to the boom.

RESULTS AND DISCUSSION

First experiment. The only change noted in the appearance of the sprayed grasses was the presence of purple color on some of the

leaf blades; this was noted eight days after the treatments were applied. One month after spraying, spikes of *Andropogon aciculatus* were noted in the unsprayed plots but not in the sprayed plots (fig. 1). Also, there was more growth in the unsprayed plots than in the sprayed so that there was a line of demarcation between them. Yield data were not obtained because of the accidental mowing of the plots by the College laborers.

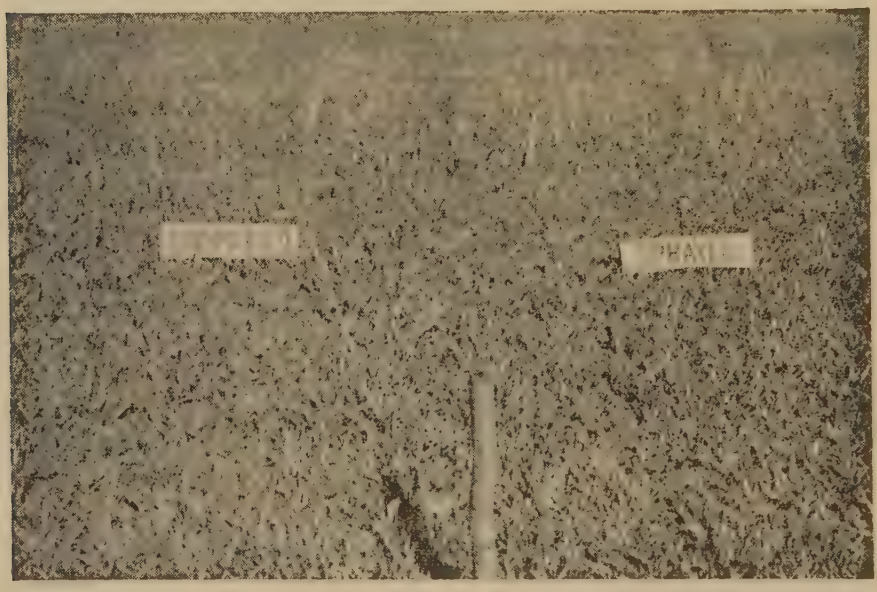

Fig. 1.—The effect of 0.5 per cent maleic hydrazide on *Andropogon aciculatus*. Note the presence of flower spikes in the unsprayed portion and their absence in the sprayed portion. Sprayed June 11, 1953; photographed July 17, 1953, by the Photographic Division.

Second experiment. Four days after spraying, tips of grasses sprayed with 2.0 per cent maleic hydrazide were already brown. There were no apparent differences among treatments I, II, III, and IV. Ten days after spraying some changes were noted in the different lots. In lot I some flower shoots had come out, and in others, the flowers were already elongated but the shoots had not opened. The only change in appearance in lot III was the presence of the purplish pigment in some of the leaves. In lot IV there was a slight browning of tips of some of the leaves. In lot V browning was progressing downwards so that about one-half of the leaf blades were already brown by that time.

At 14 days, the inhibiting effect of MH could be seen clearly. The grasses in the unsprayed lots were definitely taller than those sprayed with 0.5 per cent, 1.0 per cent, or 2.0 per cent maleic hydrazide. There was very little, if any, inhibiting effect brought about by 0.25 per cent maleic hydrazide spray (fig. 2).

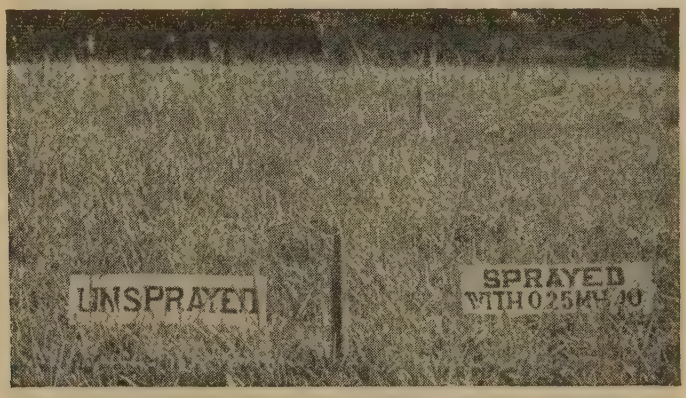

Fig. 2.—Effect of 0.25 per cent maleic hydrazide at 1,000 li./ha. on lawn grasses. Sprayed August 7, 1954; photographed September 9, 1954, by the Photographic Division.

Although 2.0 per cent maleic hydrazide decidedly inhibited growth, it was not a desirable concentration to use because of the discoloration produced. (fig. 3). Grasses sprayed with 1.0 per cent maleic hydrazide showed slight browning of leaves especially at the tips, whereas those sprayed with 0.5 per cent maleic hydrazide exhibited no change in appearance (figs. 2 and 3). These differences among the different treatments became more marked as the experiment progressed, for the unsprayed grasses kept on growing while the sprayed lots remained inhibited. The grasses sprayed with 2.0 per cent maleic hydrazide exhibited the brown color until the end of the experiment on September 23.

The fresh weights of the clippings from the different lots are presented in table 1. It will be noted that clippings from lots III and IV were about one-half those from the unsprayed lots. The average weight of the clippings from lot II was about three-fourths that of the unsprayed lot. There was practically no growth in the lot sprayed with 2.0 per cent maleic hydrazide.

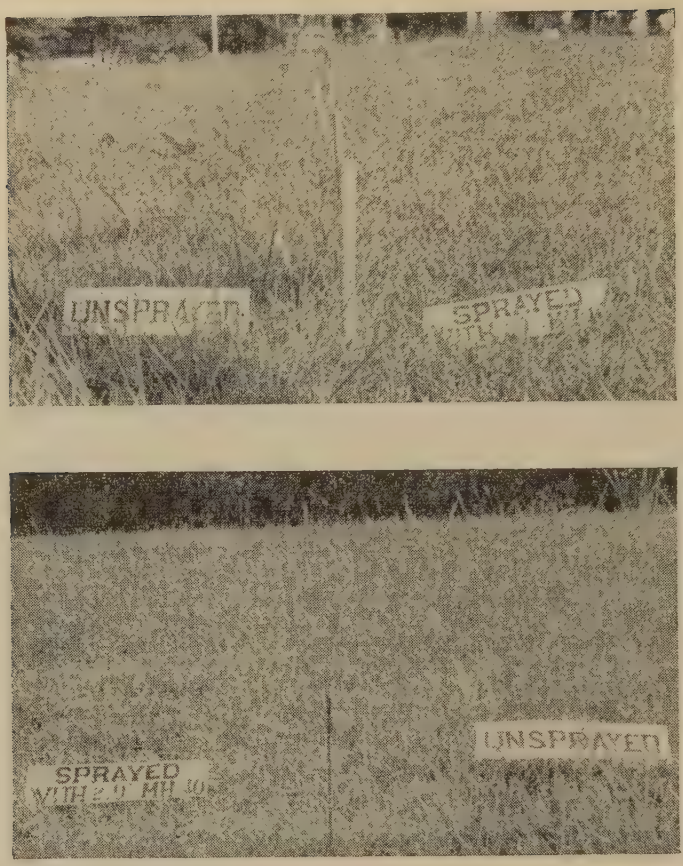

Fig. 3.—Effects of 1.0 and 2.0 per cent maleic hydrazide sprayed at the rate of 1,000 li./ha. on lawn grasses. Sprayed August 1, 1954; photographed September 9, 1954, by the Photographic Division.

TABLE 1.—*Weight of clippings in grams from plots sprayed with different concentrations of maleic hydrazide in experiment II*

LOT NO.	TREATMENT [a]	REP. 1	REP. 2	REP. 3	REP. 4	AVERAGE
I	0.25% MH	860	930	1,055	348	798.2
II	0.5 % MH	235	650	375	936	549
III	1.0 % MH	470	240	349	704	440.7
IV	2.0 % MH	50	97	162	55	91
V	Untreated (check)	910	1,025	760	1,171	966.6

[a] All concentrations of MH applied at the rate of 1,000 li./ha. Plots treated August 7, 1954; harvested September 24, 1954.

The results of this experiment tend to show that 0.5 per cent maleic hydrazide sprayed at 1,000 li/ha. was the best concentration used (fig. 4).

Fig. 4.—Effect of 0.50 per cent maleic hydrazide at the rate of 1,000 li./ha. Note comparatively shorter grasses in sprayed lot, the presence of spikes of *Andropogon aciculatus* and *Imperata cylindrica* in unsprayed lot, and their absence in sprayed lot.

Sprayed August 7, 1954; photographed September 9, 1954, by the Photographic Division.

Third experiment. The first effect of the maleic hydrazide was noted five days after the treatments. The grass leaves in the treated plots were purplish in color mostly along the margins and tips. Judged by this criterion, however, the different treatments could not be distinguished from one another. The purplish color was probably

anthocyanin. Crafts *et al.* (1950) reported that a common response of plants to maleic hydrazide is anthocyanin pigmentation which might result from carbohydrate accumulation in leaves.

As early as November 29, or nine days after the treatments, the untreated plots could be singled out by the amount of regrowth which had taken place.

At 13 days, slight browning of the leaves was noticed in plots sprayed with 1.0 per cent maleic hydrazide at 500 li./ha. (III) and in those sprayed with 0.5 per cent maleic hydrazide at 1,000 li./ha. (IV). Also at about this time, the untreated plots felt smooth under the palm of the hand, whereas the treated plots felt rough. This may have been due to the fact that the unsprayed grass was growing and thus had succulent tips.

TABLE 2.—*Weight of clippings in grams from plots treated with MH-40 in experiment III* [a]

LOT NO.	TREATMENT	DAYS AFTER TREATMENT AT HARVEST	REP. 1	REP. 2	REP. 3	REP. 4	AVERAGE
I	0.5% MH at 500 li./ha.	40	8.5	6.3	8.3	4.3	6.85
		60	3.6	16.9	5.3	9.2	8.75
		80	27.4	58.5	134.6	87.0	76.87
		100	24.6	40.9	141.9	96.2	75.90
II	0.25% MH at 1,000 li./ha.	40	13.7	7.5	11.8	21.6	13.65
		60	4.7	5.9	35.4	25.9	17.97
		80	16.1	9.8	78.4	105.2	52.37
		100	25.8	63.8	30.8	27.4	36.95
III	1.0% MH at 500 li./ha.	40	37.0	8.6	5.8	7.0	14.60
		60	4.3	67.0	26.2	14.0	27.87
		80	99.6	52.0	89.0	25.0	66.40
		100	35.2	26.6	80.4	49.1	47.82
IV	0.5% MH at 1,000 li./ha	40	8.7	9.5	14.3	9.4	10.47
		60	8.1	14.6	7.5	24.1	13.57
		80	38.9	32.4	128.7	48.0	62.00
		100	31.7	20.0	116.6	37.0	51.32
V	Untreated (control)	40	49.6	41.0	77.6	79.9	62.02
		60	9.5	12.3	100.2	14.4	34.10
		80	28.7	61.5	63.7	305.6	114.87
		100	30.2	51.8	44.2	45.8	43.00

[a] Treated November 20, 1955.

The slight browning noticed in III and IV persisted up to about 70 days after treatment when all treated plots that were not yet harvested, those to be cut at 80 days, had started to send out new blades. Engel *et al.* (1950) reported that when maleic hydrazide was sprayed on turf at 0.6 to 2.4 lb. in 200 gal. of water per acre, all the treated areas were considered normal six weeks after treatment.

The weight of the fresh clippings from the different plots may be seen in table 2. It will be noted that up to 80 days after treatment the harvest from the treated plots was decidedly less than that from the untreated plots. The lowest yield of grass clippings both at 40 and 60 days, before the treated plots sent out new blades, was obtained from the plots sprayed with 0.5 per cent maleic hydrazide at 500 li./ha., followed by those from IV (0.5 per cent at 1,000 li./ha.), II (0.25 per cent at 1,000 li./ha.), and III (1.0 per cent at 500 li./ha.).

Fourth experiment. Grasses from both treated and untreated plots turned brownish, more so as the dry season progressed. The harvests from the sprayed and unsprayed plots were nearly the same in weight up to 100 days after spraying (table 3).

TABLE 3.—*Weight of clippings in grams from plots treated with maleic hydrazide in experiment IV* [a]

LOT NO.	TREATMENT	DAYS AFTER TREATMENT AT HARVEST	REP. 1	REP. 2	REP. 3	REP. 4	AVERAGE
I	0.5% MH 500 li./ha.	40	123.9	118.7	195.2	150.0	146.9
		60	60.0	65.3	54.1	62.1	60.3
		80	53.9	66.8	75.3	65.7	65.4
		100	24.0	36.0	45.0	47.0	38.0
II	Untreated (check)	40	127.3	127.1	202.2	140.0	149.1
		60	30.2	46.7	100.3	70.3	61.8
		80	48.5	68.0	95.6	83.4	73.8
		100	38.0	55.0	68.0	38.0	49.7

[a] Treated February 2, 1955.

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If I were a painter or a sculptor more interested in design than in story-telling, it seems to me that I should go instead to the living organisms, which, to anyone who looks closely, exhibit many examples of "modern" geometrical design. I should go to the blossom, which usually builds up a pattern of fives or threes; to the seed pods, which come in an infinite variety of boxes, flasks, and urns; even, if I wanted a "mobile," to the ripe fruit of the wild geranium, whose effective catapult was tossing hard round seeds many millenniums before the military engineers of the Renaissance discovered that the same principle could be used to hurl boulders at an enemy. Curiously enough, it seems that the smaller the living unit, the more exquisitely elaborate and perfect the form will be. Pollen grains which no man saw before the invention of the microscope come in an endless variety of regular shapes, and many of them are embossed or engraved with patterns which rival in intricacy those sculptured on the glass shells of the microscopic bivalves called diatoms.

—*Joseph Wood Krutch*

PERFORMANCE AND QUALITY TESTS OF GLUTINOUS STRAINS OF WHITE FLINT CORN [1]

VICENTE G. DOSADO

WITH TWO TEXT FIGURES

A comparative test of 14 glutinous strains of corn during the dry season of 1953-54 and the wet season of 1954 showed that Mt. Province gave a significantly higher yield of 38.4 cavans, which was 85 per cent over Morong, the better of the checks. The Laguna varietal check was outyielded significantly by Ilocos Sur and Isabela. During the wet-season yield trial Central Luzon excelled over all other strains, with a computed yield of 95.1 cavans to a hectare, which was 28 per cent over Morong. The number of days from planting to silking ranged from 47 to 56. Morong was rated best in eating quality, Mt. Province was second, and Ilocos Sur third. Cagayan was considered the poorest. The strains did not differ significantly in their degree of tenderness. The tenderness of the pericarp varied according to season. Five strains in the dry season and eight in the wet season had more tender pericarps. Cagayan had the best stand.

Fourteen provincial strains of "Lagkitan" or glutinous white flint were collected by the staff of the Division of Plant Breeding from 12 different provinces in 1951-52. None of these lines proved to be pure for glutinous character. Glutinous kernels were extracted from ears of each of the provincial strains in the wet season of 1952; the kernels were then bulked to make up a homozygous strain for the glutinous character of endosperm. The 14 provincial glutinous strains extracted were studied for yield and quality in the dry season of 1953-54 and in the wet season of 1954 at the Central Experiment Station and in the Plant Breeding Laboratory.

MATERIALS AND METHODS

Planting materials. The provincial strains used in this study were Mt. Province, Ilocos Sur, Isabela, Cagayan, Camarines Norte, Negros Oriental, Batanes, Central Luzon, Pangasinan, Sulu, Morong, Laguna R, Laguna A, and Laguna B.

[1] Central Experiment Station Contribution No. 1869. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture, March, 1955. Prepared in the Department of Agronomy under the direction of Drs. D. L. Umali and H. K. Hayes.

The common glutinous varieties of the Laguna Bay region, Morong and Laguna, were grown as checks. The Laguna A and B strains were selected from the Laguna varieties to represent two rather distinct forms of the glutinous character in Philippine varieties. The A form presented a more or less typical glutinous appearance, with opaque kernels which had little, if any, "soft starch"; the B form had an appearance nearly similar to that of white flint, but it was distinguished from the latter by the I-KI starch test.

Planting procedure. The percentage of germination was determined before planting. Four seeds were planted to a hill. The hills were spaced 50 cm. apart in rows 1 meter apart. Each hill was thinned to a perfect stand of two plants two weeks after planting. The dry-season planting was made on December 24, 1953, and the wet-season planting on June 1, 1954.

Experimental design. The randomized complete block design, with two replications in the dry season and four replications in the wet season, was used. Each plot consisted of three 17-hill rows. All pertinent data, except those for the quality test and the puncture indices, were taken from plants of the middle row. End hills were chopped down before harvest.

Care of plants. The plots were weeded and cultivated whenever necessary. The first application of fertilizer was made two weeks after planting at the rate of 150 kg. of ammonium sulfate per hectare. The same fertilizer was applied a second time at the rate of 100 kg. to a hectare seven weeks after planting.

Field data. Observations on the following agronomic and other characters were made: (1) number of days from planting to silking (when 50 per cent of the plants in the row had silked); (2) height of plant (from the ground level to the tip of the tassel); (3) percentage of root lodging (plant inclined 45° or more from the vertical position); (4) percentage of stalk lodging (stalks broken either below or above the ear); (5) damage caused by insect pests and diseases; (6) eating quality (ears taken from border rows 15 days after silking were cooked and rated by at least six persons for succulence, flavor, sweetness, and tenderness on a scale of 1 for the best quality and 5 for the poorest); (7) pericarp tenderness (based on four representative ears from the border rows whose degree of toughness was determined by the puncture tester). Four puncture tests were made on the central portion of each ear. The puncturing apparatus used was obtained from the Scientific Laboratory of the University

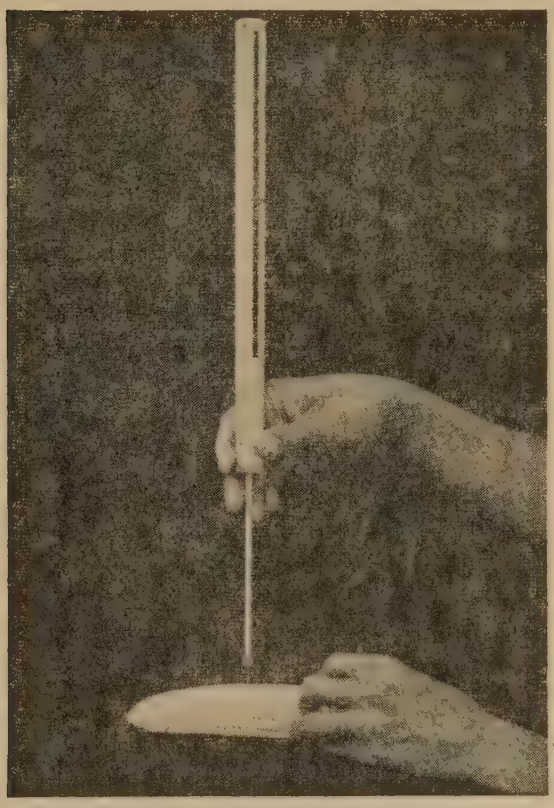

Fig. 1.—Puncturing apparatus.

of Minnesota (fig. 1). Except for its aluminum tube, it was similar to that described by Culpepper and Magoon.[2]

Data taken after harvest. The ear length (from at least four representative ears measured from butt to tip), number of kernel rows, number of good and poor ears (from the number of hills harvested), and yield (based on the grain yield of the middle row of each plot at 16 per cent moisture) were recorded.

DISCUSSION OF RESULTS

Yield

The hectare yields of the different glutinous strains in the 1953 dry season are presented in table 1.

[2] C. W. Culpepper and C. A. Magoon, *Jour. Agric. Res.*, 28, 403 (1924).

TABLE 1.—*Computed yield in cavans per hectare of the different glutinous strains*

STRAIN	REPLICATION		MEAN
	I	II	
Mt. Province (R)	32.0	44.7	38.4
Ilocos Sur (R)	27.3	29.0	28.2
Isabela (R)	24.7	26.9	25.8
Cagayan (R)	26.9	22.6	24.8
Camarines Norte	22.4	21.0	21.7
Morong (check)	17.7	23.7	20.7
Laguna B	17.5	20.7	19.1
Pangasinan (R)	16.7	20.6	18.7
Laguna A (check)	18.8	12.5	15.7
Sulu	17.1	12.8	15.0

SMD .05 = 9.1 cavans
.01 = 13.1 "

Analysis of variance

SOURCE	DF	MS	CF
Strains (S)	9	96.11	5.94 [a]
Reps (R)	1	8.98	0.56
(S × R)	9	16.17	

[a] Significant at P = .01 level.

The strains differed significantly in yielding potentiality. The strain from Mt. Province gave the highest mean yield of 38.4 cavans, which was significantly higher than that of Morong, the better check (20.17 cavans). The calculated SMD was 9.1 cavans at the 5 per cent point and 13.1 at the 1 per cent level of significance. Ilocos Sur and Isabela significantly outyielded the Laguna varietal check. Some strains which had been damaged by stray animals could not be included in the analysis because of their poor yield.

Table 2 summarizes the yielding ability of the different glutinous strains in the 1954 wet-season planting at the College.

The variation between strains exceeded the 1 per cent level, showing that the differences in yielding ability of the strains were highly significant. The computed SMD was 12.4 at the 5 per cent level and 16.6 cavans at the 1 per cent level. In both seasons, Morong yielded more than Laguna. Central Luzon gave a mean yield of 95.1 cavans to a hectare, which was higher than the average yield of the better check (73.7 cavans).

TABLE 2.—*Computed hectare yield in cavans of the different glutinous strains*

STRAIN	REPLICATION				MEAN
	I	II	III	IV	
Central Luzon	102.9	101.4	88.9	87.3	95.1
Batanes (R)	81.7	89.0	72.3	82.1	81.3
Laguna (R)	74.9	83.3	89.3	75.1	80.6
Morong (check)	89.6	54.3	87.0	64.0	73.7
Mt. Province (R)	78.5	78.2	64.4	71.7	73.2
Camarines Norte (R)	79.3	82.1	52.4	62.9	69.2
Ilocos Sur (R)	68.8	73.9	60.4	73.8	69.2
Isabela (R)	62.7	69.7	57.8	69.8	65.0
Pangasinan (R)	69.3	59.5	72.4	56.5	64.4
Negros Oriental (R)	62.9	58.3	64.6	69.0	63.7
Laguna (check)	62.0	60.3	59.7	71.3	63.3
Sulu (R)	62.1	71.7	58.0	44.7	59.1
Cagayan (R)	62.6	57.5	59.5	52.8	58.1

SMD .05 = 12.4 cavans
.01 = 16.6 "

Analysis of variance

SOURCE	DF	MS	CF
Strains (S)	12	431.53	5.65 [a]
Reps (R)	3	110.96	1.45
(S × R)	36	76.33	

[a] Significant at P = .01 level.

Mt. Province, the highest yielder in the dry season, ranked number 5 in the wet season. Its mean yield of 73.2 cavans was slightly lower than that of Morong glutinous. These results showed that one strain reacted differently under different seasons.

Agronomic characters

The summary of the data on plant height in centimeters, average number of days from planting to silking, percentage of root and stalk lodging, number of good ears to a plant, number of kernel rows, and ear length in centimeters are presented in table 3.

Height of plants. The mean height of all the strains studied ranged from 188 to 217 centimeters. Camarines Norte was the tallest with a mean height of 217 centimeters; Laguna glutinous, the shortest with a mean height of 188 centimeters.

TABLE 3.—*Some agronomic characters of the glutinous strains* [a]

STRAIN	PLANT HEIGHT	DAYS TO SILKING	LODGING		NO OF GOOD EARS A PLANT	NO OF KERNEL ROWS	EAR LENGTH
			Root	Stalk			
	cm.		*per cent*	*per cent*	*per cent*		*cm.*
Camarines Norte	217	52	1.79	2.68	0.69	14	12.6
Central Luzon	216	54	1.92	1.92	0.69	14	12.5
Isabela	216	54	0.82	1.66	0.70	13	11.5
Morong (check)	215	56	2.75	7.28	0.65	14	13.2
Mt. Province	214	53	0.83	—	0.79	13	13.4
Laguna (R)	213	53	—	3.75	0.71	13	11.8
Batanes	212	55	—	1.04	0.70	14	13.9
Pangasinan	212	53	—	2.21	0.73	14	11.8
Negros Oriental	206	51	2.68	0.89	0.61	13	12.2
Sulu	202	50	2.83	1.70	0.67	13	12.3
Cagayan	198	47	—	—	0.77	14	11.4
Ilocos Sur	197	50	0.87	0.87	0.79	14	12.1
Laguna	188	51	2.27	4.19	0.68	13	11.8

[a] Averages for both seasons.

Days to silking. The number of days from planting to silking of the different strains ranged from 47 to 56. Cagayan was the first to silk and Morong, the last.

Lodging. The stand of all the strains was excellent. There was a slight root and stalk lodging in both seasons. Cagayan excelled in standing ability; it did not show either stalk or root lodging characteristics in both seasons.

Number of kernel rows and ear length. The different strains did not differ much in mean number of kernel rows or average ear length.

Insect pests and diseases. Insect injuries observed were largely due to *Pyrausta suppresalis* (Walker).[3] All the plants were attacked by this pest, but they were not severely damaged.

Eating quality. In the comparative test for eating quality, Morong was rated the best with 1.98 points (table 4). The second choice was Mt. Province with 2.21, and the third, Ilocos Sur with 2.46 points. Cagayan was considered the poorest. In all cases, the grading was done without a knowledge of the puncture indices of all the cultures being tested.

[3] Identified by Dr. S. M. Cendaña of the Department of Entomology.

TABLE 4.—*Comparison of the eating quality of the glutinous strains*

STRAIN	DRY SEASON AVERAGE	WET SEASON AVERAGE	MEAN
Morong	1.90	2.06	1.98
Mt. Province (R)	1.81	2.61	2.21
Ilocos Sur (R)	2.17	2.75	2.46
Negros Oriental (R)	2.67	2.48	2.58
Isabela (R)	2.50	2.87	2.69
Laguna (R)	2.44	2.99	2.72
Batanes (R)	2.87	2.75	2.81
Pangasinan (R)	3.29	2.43	2.86
Laguna	3.09	2.75	2.92
Sulu (R)	3.29	2.69	2.99
Camarines Norte (R)	3.24	2.88	3.06
Central Luzon	3.21	2.93	3. 8
Cagayan (R)	3.58	2.97	3.07

Puncture-test index. Average puncture test indices for the dry and wet-season cultures are summarized in table 5. Index averages were based on four ears to a plot. Although the over-all average indices of the lines ranged from 289 to 329, the differences were not significant. Similarly, there was no significant difference between the season averages of 306 and 313. The analysis of variance showed that this may have been due in large part to the suggestive significant interaction of strains and seasons (fig. 2). Eight of the lines showed a much more tender rating in the wet than in the dry season, whereas the remaining five lines were rated more tender during the dry season. The SMD applying to these "strain-within-season" averages was 35.1 index points.

The pericarps of Negros Oriental, Mt. Province, Morong, Sulu, and Central Luzon were more tender in the dry than in the wet season; the reverse was true for Ilocos Sur, Cagayan, Laguna (R), Isabela, Batanes, Laguna, and Pangasinan. However, the pericarp of Camarines Norte had about the same texture in both seasons.

In the dry season, Negros Oriental had the most tender pericarp but in the wet season, Ilocos Sur did. In general, the wet-season culture was found to be more tender.

Doxtator[4] observed a pronounced seasonal difference in the puncture indices of 11 cultures in a five-year test of Golden Bantam Sweet Corn in Minnesota.

[4] C. W. Doxtator, *Jour. Amer. Soc. Agron.*, 29, 735 (1937).

TABLE 5.—*Puncture test values*

STRAIN	DRY SEASON	WET SEASON	MEAN
Negros Oriental	282	296	289
Ilocos Sur	296	287	292
Cagayan	307	291	299
Mt. Province	295	306	301
Laguna (R)	319	297	308
Camarines Norte	312	307	310
Morong	296	327	312
Isabela	319	309	314
Batanes	332	299	316
Sulu	312	326	319
Central Luzon	315	332	324
Laguna	353	298	326
Pangasinan	349	308	329
Mean	313	306	310

SMD at .05 (strain × season) = 35.1

Analysis of variance

SOURCE	DF	SS	MS	F
Strain (St.)	12	34,498.72	2,874.89	
Season (S)	1	2,968.46	2,968.46	
St. × S	12	42,810.97	3,567.58	1.92 [a]
Rep w/in season	4	2,565.53	641.38	
Pooled St. × R	48	88,969.04	1,853.52	
Pooled sampling error	234	273,842.50	1,170.27	
Total	311	445,655.22		

[a] Significant at P ≅ .05 level.

Magoon and Culpepper [5] stated that taking into consideration the excessive toughness of overmature corn on one hand and the too thin consistency of immature corn on the other, corn grading in resistance to puncture between the limits of 250 and 325 grams, as measured by this method, yielded a product of the highest quality.

The pericarp of Morong, the strain with the best eating quality in both seasons, was not the most tender; however, its puncture value falls within the range of pericarp tenderness of good quality green corn. The slight irregularity which is indicated by the figures in table 5 may have been primarily due to the uneven maturity of the ear samples used although an earnest endeavor had been made to choose only those ears which were truly representative of the strain under study.

[5] C. A. Magoon and C. W. Culpepper, *Jour. Agric. Res.* **33**, 1043 (1926).

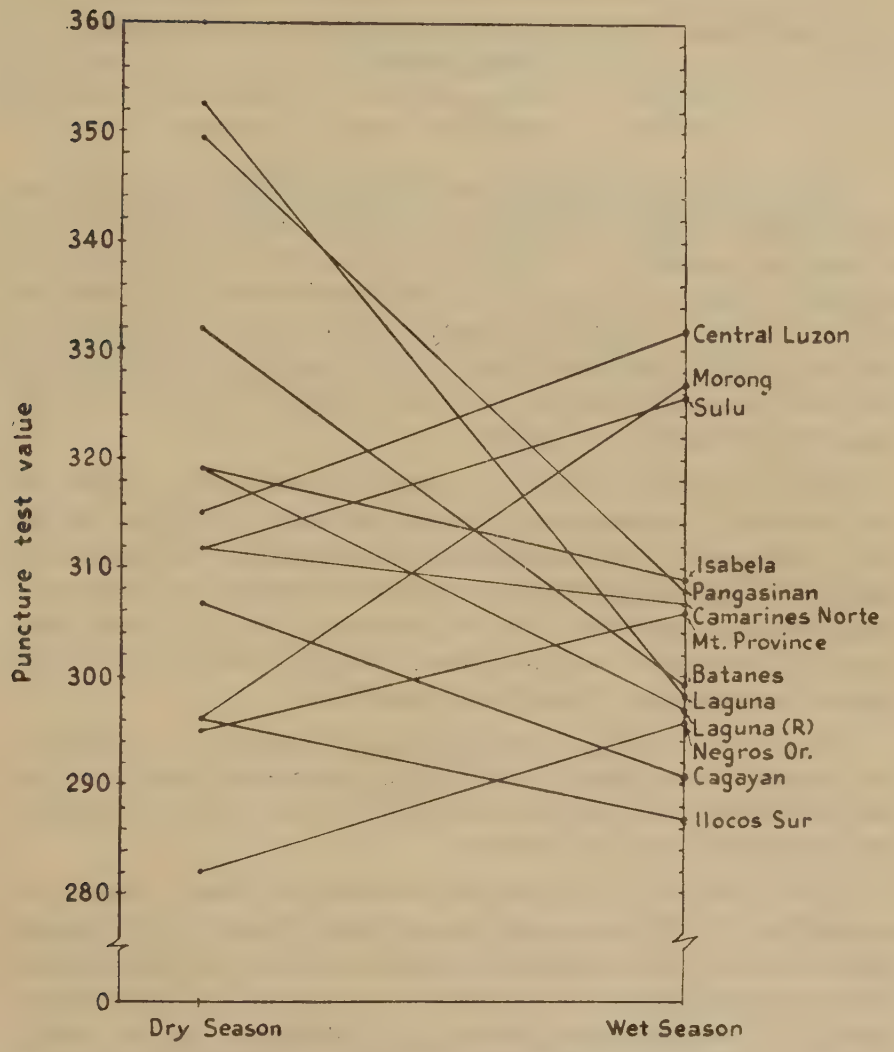

Fig. 2—Puncture test values of the different strains in the dry and wet seasons. SMD = .05 = 35.1 applies to average of any season.

POSSIBLE PHILIPPINE SOURCES OF VITAMINS: I. CAROTENE [1]

MAMERTA M. YLAGAN AND LAURO A. YNALVEZ

The carotenoid pigments are found primarily in yellow and green plants. They are important in vitamin nutrition because some of them are converted into vitamin A in the body. They are the precursors of vitamin A and are called "provitamins A", which are generally absent from animal organs since they are not stored as such but are converted into vitamin A. A few exceptions to this general rule must be noted, however, for traces of provitamin A have been found in fat deposits of animals.

The provitamins A most frequently encountered are alpha and beta carotene (hydrocarbons) and cryptoxanthin (hydroxy derivative) or its esters. The most common nonvitamin A precursors are xanthophyll and the xanthophyll esters and lycopene (hydrocarbon). Beta carotene was found to be the predominant form in most foods containing carotene. It is the easiest of all provitamins A to obtain in pure form because it is optically inactive.

Twenty-six samples of Philippine plant materials were analyzed for carotene. Two samples were grain, yellow and white corn, and one was a fruit. The rest were or could be used as leafy vegetables and roughages for animal feeding.

The result are here presented because they seem to bring out certain facts which suggest new lines of study (table 1). The results seem to indicate that drying destroys the carotene. It was very apparent that the faster the drying the less the loss of the carotene. This has a very important bearing on the drying of hay for animal feeding. It also appears that carotene is low on a rainy and windy day.

The results with ipil-ipil and lettuce also show that the plants which were planted in plots exposed to strong sunshine the whole day had lower carotene content than the plants planted in partially

[1] Central Experiment Station Contribution No. 1870.

shaded plots, those which received only two to three hours of sunshine during the day. Since the lettuce grown in partially shaded plots appeared to be more succulent than the plants grown in plots exposed to the sun the whole day, it is apparent that this study should be extended further.

It likewise appears that keeping vegetables in a refrigerator is not very essential. The local practice of immersing the bases of vegetables in water seems to be sufficient to keep in the carotene for about 24 hours.

The results also show that 46- to 66-day-old ipil-ipil seedlings with a height of 18 to 38 centimeters had a higher carotene content than the leaves collected from older trees.

TABLE 1.—*Carotene content in mcg./100 grams of 26 moisture-free samples*

SAMPLE	CAROTENE CONTENT
Alfalfa hay, *Medicago sp.*	403
Alogbati, *Basella rubra* Linn.	15,929
Ampalaya tips, *Momordica charantia* Linn.	19,328
Balatong aso, *Cassia tora* Linn.	
Fresh	28,000
Dried in the oven	10,581
Dried in the sun	8,419
Kamote vine, *Ipomoea batatas* Linn.	
Fresh	24,585
Dried in the oven	16,556
Dried in the sun	11,774
Kamote vine tips, fresh	12,127
Kamokamotihan, *Ipomea triloba* (Linn.) Jacq.	
Fresh	19,975
Dried in the oven	12,331
Dried in the sun	7,047
Corn grains, *Zea mays* Linn.	
Yellow	454
White	144
Calopogonium mucunoides Desv.	
Fresh	11,723
Dried in the oven	10,849
Dried in the sun	5,518
Centrosema pubescens Benth.	
Fresh	14,448
Dried in the oven	13,728
Dried in the sun	12,460
Kalabasa tips, *Cucurbita maxima* Duch.	
Fresh	12,465
Kept at ordinary room conditions one day	9,362
Kept at ordinary room conditions two days	9,233
Kept in refrigerator one day	10,455
Kept in refrigerator two days	5,481
Bases immersed in water one day	10,076
Bases immersed in water two days	9,518
Cucharita, *Alternanthera versicolor* Forskal	
Fresh	14,421
Dried in the oven	—
Dried in the sun	2,000
Kept at ordinary room conditions:	
One day	12,100
Two days	11,984
Three days	10,178
Four days	9,377
Five days	7,423
Kept in the refrigerator:	
One day	13,547
Two days	10,133
Three days	8,462
Four days	7,914
Five days	6,847
Bases immersed in water:	
One day	14,156
Two days	13,750
Three days	11,464
Four days	10,476
Five days	10,030
Cogon, *Imperata cylindrica* (Linn.) Beauv.	
Fresh	13,714
Dried in oven	8,603
Dried in sun	7,766
Ipil-ipil, *Leucaena glauca* (Linn.) Benth.	
Open plot:	
From an old tree near sugar mill	19,772
From an old tree near Palma Bridge	21,356
From an old tree in Raymundo barrio	22,488
From an old tree near Rural High School	24,373
Dried in the oven	24,110
Dried in the sun	9,733
46-day-old seedlings cut 3 inches above ground	30,852
57-day-old seedlings cut 3 inches above ground	28,513

TABLE 1 (continued)

SAMPLE	CAROTENE CONTENT
66-day-old seedlings cut 3 inches above ground	27,264
81-day-old seedlings cut 3 inches above ground	22,732
88-day-old seedlings cut 3 inches above ground[a]	13,869
91-day-old seedlings cut 3 inches above ground	19,666
101-day-old seedlings cut 3 inches above ground	18,523
110-day-old seedlings cut 3 inches above ground	13,002
120-day-old seedlings cut 3 inches above ground	12,999
Shaded plot:	
61-day-old seedlings cut 1 inch above ground	33,388
74-day-old seedlings cut 1 inch above ground	30,081
Lettuce, *Lactuca sativa* Linn., var. black seeded Simpson	
Fresh	14,616
Kept at ordinary room conditions one day	14,098
Kept at ordinary room conditions two days	—
Kept in refrigerator one day	10,513
Kept in refrigerator two days	—
Bases immersed in water one day	13,905
Bases immersed in water two days	—
Shaded	22,309
Exposed to sun	19,353
Malunggay leaves, *Moringa oleifera* Lam.	30,098
Mustard, *Brassica juncea* F. Vill, var. Southern giant curl	
Fresh	37,003
Kept at ordinary room conditions one day	21,469
Kept at ordinary room conditions two days	13,778
Kept one day in refrigerator	23,506
Kept two days in refrigerator	12,544
Bases immersed in water one day	16,870
Bases immersed in water two days	12,960
Kakawati, *Gliricidia sepium* (Jacq.) Steud.	
Fresh	18,291
Dried in oven	16,410
Dried in sun	13,785
Chinese pechay, *Brassica pekinensis* Rupr.	
Fresh	25,255
Kept at ordinary room conditions one day	15,149
Kept at ordinary room conditions two days	14,747
Bases immersed in water one day	19,664
Bases immersed in water two days	19,563
Kept one day in refrigerator	21,953
Kept two days in refrigerator	14,685
Saluyot tips, *Corchorus capsularis* Linn.	30,049
Chileng-bundok, *Capsicum frutescens* Linn.	22,644
Spinach, *Spinacia oleracea* Linn.	25,201
Talinum, *Talinum triangulare* (Jacq.) wild	16,978
Canistel fruit (tieza), *Lucuma nervosa* A. DC.	26,912
Tick clover, *Desmodium intortum*	
First cutting fresh	11,570
First cutting dried in oven	7,680
First cutting dried in the sun	5,717
Second cutting fresh	10,423
Second cutting dried in oven	7,085
Second cutting dried in the sun	4,268
Talahib, *Saccharum spontaneum* Linn.	
Fresh	15,023
Dried in the oven	10,182
Dried in the sun	8,143

[a] Harvested and analyzed after a typhoon.

MARKETING PINEAPPLES FROM INDANG AND AMADEO, CAVITE, IN 1954 [1]

TOMAS M. VEJERANO

Of the 170 farmers surveyed, the tenant-operators had a smaller average production than the owner-operators. About 87 per cent of the total production was sold in the local market; the balance went to Manila. The fruits were mostly sold by the hundred. The prices paid for fresh fruits in Cavite were lower than those in Manila. Most of the fruits marketed in Manila were of better quality than those sold in the local market.

Sales in the local market were exclusively to wholesalers. Of the owners who sold in Manila, 88 per cent sold at retail and 12 per cent at wholesale. The types of sale were by cash, installment, and "after delivery." Sale by cash was prevalent in Cavite. More than 50 per cent of the farmers hauled the pineapples to the local market on their backs. The fruits shipped to Manila were exclusively hauled by motor trucks.

The marketing problems of the fruit growers included inadequate facilities for bringing the products to the market, alleged control of prices by middlemen, and competition among growers in the individual sale of their produce.

Pineapple is one of the important crops of the province of Cavite. Annually, large quantities of pineapple fruits find their way to the markets of the neighboring towns and Manila. These fruits are mostly produced in the upland towns of Cavite.

To determine some of the marketing operations involved in selling pineapples, common practices used, and problems encountered, a survey was made early in 1954 in the principal pineapple producing towns of Indang and Amadeo, Cavite.

The data gathered included area planted, varieties grown, amount of pineapple harvested, method of selling, estimated marketing costs, and other pertinent information. Observations were made to supplement the information gathered by personal interview. Buyers of various products from different towns and retailers in public markets were also interviewed.

[1] Central Experiment Station Contribution No. 1871.

PRODUCTION

Farms planted to pineapple. Of the 170 pineapple farms surveyed, 124 were located in Indang and 46 in Amadeo (table 1). These farms had an average area of 0.9 hectare.

TABLE 1.—*Number of farms and area planted to pineapples*

TENURE	NUMBER OF FARMS			AVERAGE NUMBER OF HECTARES
	Indang	Amadeo	Total	
Tenant	25	4	29	0.7
Owner	99	42	141	0.2
Total	124	46	170	0.9

Utilization of farm area. Pineapple was the principal crop grown by all 170 farmers (table 2). The area planted to pineapple was part of the orchard land. The other important crops grown were upland rice and coconut.

TABLE 2.—*Utilization of crop area*

LAND USE	NUMBER OF HECTARES PER FARM		
	Tenant-operated	Owner-operated	All farms
Orchard	1.1	1.1	1.1
Pineapple	(0.7)	(0.9)	(0.9)
Upland rice	0.3	0.1	0.2
Coconut	0.9	0.4	0.5
Corn	—	a	a
Average farm area	2.9	2.6	2.6

[a] Less than 0.1 hectare.

Varieties. The varieties of pineapple planted were native, Pinyang Tomas, and Pinyang Dasoy. The native pineapple was, until recently, the only variety grown on a large scale in Cavite. It was the most widely grown of the three varieties of pineapple planted in the area (table 3).

Sharing system. Under the common leasing arrangements it was the duty of the tenant to clean, fence, and take care of the plantation. He was expected to harvest the crop, haul the product from the field to the house, and transport it from there to the market. For this he received one-half of the proceeds from his holdings.

TABLE 3.—*Varieties grown*

VARIETY	PER CENT FARMERS GROWING	
	Tenant	Owner
Native	76	75
Pinyang Tomas	—	2
Pinyang Dasoy	3	5
Combination of three	21	18
Total	100	100

The landlord supplied the necessary materials for the care of the plantation and advanced some money for which no interest was generally charged. The tenant usually paid the cash advances after the crop was marketed.

When other crops were planted on the plantation, the landlord and tenant also shared the produce equally when the work animals, equipment, and planting materials were furnished by the landlord. The tenant took all of the produce when the landlord did not furnish any of the production materials. However, it was the common practice for the tenant to give the landlord a little of the harvest.

Harvesting. The fruits were cut from the plants with a sharp bolo and piled in convenient places on the plantation. The quantity harvested depended on the number of fruits which were mature and ready for market. The crowns, slips, and peduncles were removed by the operator before the product was hauled over the land routes.

Average production and yield. The tenant-operators had a smaller production per farm than owner-operators, but their yield per hectare was slightly higher (table 4).

TABLE 4.—*Production per farm and per hectare*

FARMERS	NUMBER	
	Per farm	Per hectare
Tenants	4,248	5,730
Owners	4,946	5,624

MARKETING

Markets. Of the 29 tenant-operators, 27 disposed of their produce in the local market and 2 in Manila. There were 124 owner-operators who marketed their produce in the local market and 17 in Manila.

Tenants with large total production shipped to Manila (table 5). The tendency for bigger producers to ship their produce to Manila was also observed among the owner-operators. The owner-operators selling their produce locally generally had small production than those owner-operators selling in Manila.

TABLE 5.—*Relation of production and market outlets*

FARMER	LOCAL MARKET	MANILA
Tenant	3,951	8,250
Owner	4,880	5,530

Disposal. The farmers, whether tenant or owner, sold most of the pineapples they grew (table 6). About 87 per cent of the production was sold in the local market. The balance, 13 per cent, was sold in the Manila market.

The unit of sale used by 153 of the 170 farmers was 100 pieces to the unit. Only 17 reported having sold pineapples by the piece. All growers who sold their produce in the local market used 100 pieces as the unit of sale. On the other hand, only two owner-operators sold their produce in Manila by the hundred.

The prices depended on the size and general appearance of the fruits. Prices paid for fresh fruits in Cavite were generally lower than those paid in Manila (table 6). The difference in price may be accounted for by distance to market, quality of the product, and type of sale.

TABLE 6.—*Quantity price and receipts*

ITEM	TENANT		OWNER	
	Local market	Manila	Local market	Manila
Pineapples sold per farm	3,814	8,135	4,667	5,204
Pineaples used at home	137	115	213	226
Price per hundred:				
Large	₱13.75	₱23.80	₱11.73	₱25.71
Medium	10.01	16.23	8.81	19.02
Small	6.20	8.56	5.57	9.21

Hosillos [2] stated that products of high quality, as evidenced by freshness, good general appearance, and physical condition of the

[2] L. V. Hosillos, *Philippine Agriculturist* **36**, 158 (1952).

commodity, command better prices other considerations being equal. The same was probably true of the farmers in Cavite although information on this was not obtained.

Grading. The bases for grading fruits were size, uniformity of shape, color, absence of surface mechanical injuries, and relative freshness. The farmers used their own judgment in their selection of fruits.

Pineapples shipped to distant markets were usually of good quality. Most of the poorer grades were disposed of in the local market (table 7).

TABLE 7.—*Quality of pineapple*

QUALITY	TENANT		OWNER	
	Local market	Manila	Local market	Manila
	per cent	*per cent*	*per cent*	*per cent*
Good	52	100	58	94
Poor	48	—	42	6
Total	100	100	100	100

Distance traveled. Most of the produce was grown within a short distance from the house but a long distance from the markets. Farmers who sold their produce locally had to travel an average of 3.3 kilometers from their farms to the market (table 8). The distance to the Manila market averaged 74.0 kilometers.

TABLE 8.—*Distance traveled in marketing pineapples*

OUTLET	KILOMETERS FROM FIELD TO	
	House	Market
Local market	1.2	3.3
Manila	1.5	74.0
Total	2.7	77.3

Method of transporting. The growers who sold directly to buyers in the markets were responsible for hauling the produce to the markets. More than 50 per cent of the farmers hauled the produce from field to house on their backs (table 9). The pineapples were carried in two baskets attached to a bamboo pole which the carrier placed over his shoulder.

TABLE 9.—*Some marketing services performed*

SERVICE	MARKET OUTLETS			
	Local market		Manila	
	Number	Per cent	Number	Per cent
Hauled from farm by seller	150	100	19	100
Method of hauling from field to house:				
Carried on shoulder	82	54	13	68
Pack horse	69	46	6	32
Graded by:				
Seller	151	100	16	84
Buyer	—	—	3	16
Method of transporting to market:				
Carried on shoulder	21	14	—	—
Pack horse	23	15	—	—
Truck	107	71	19	100

Time required in marketing. In all operations related to marketing, selling to the local market took less time (table 10). The trimming took only a slightly shorter time, but hauling to the house took a significantly shorter time although the distance was only slightly less.

TABLE 10.—*Time involved in marketing*

OPERATION	MINUTES PER HUNDRED	
	Local market	Manila
Removing the crowns, slips, and peduncles	18	20
Hauling to house	30	40
Transporting to market	21	124
Selling	21	37

Much more time was incurred in transporting pineapples to Manila markets than to the local market because of the longer distance involved. Even the time involved in selling pineapples in the local market was usually shorter than at Manila. This was because the commodities were sold mostly for cash to wholesale buyers in the local market.

Methods of marketing. Transactions in the local market were exclusively with wholesalers. The wholesalers or middlemen who purchased the produce at the local market resold it in the local area or shipped it to Manila.

One hundred per cent of the tenants selling at Manila sold to retailers (table 11). Of the owner-operators, 88 per cent sold at retail and 12 per cent on a wholesale basis.

TABLE 11.—*Methods of marketing*

BUYERS	TENANT		OWNER	
	Local market	Manila	Local market	Manila
	per cent	*per cent*	*per cent*	*per cent*
Wholesalers	100	—	100	12
Retailers	—	100	—	88
Total	100	100	100	100

Type of sale. More transactions were made on a cash basis than any other type of sale (table 12). Usually the farmers took their produce to town on regular days and peddled it to regular customers. The advantage of this method is that the sale is usually for cash and the farmer gets money immediately to pay his bills.

TABLE 12.—*Type of sale*

TYPE	TENANT		OWNER	
	Local market	Manila	Local market	Manila
	per cent	*per cent*	*per cent*	*per cent*
Cash	78	100	88	71
Installment	11	—	1	29
After delivery [a]	11	—	11	—

[a] Receipts from sale were given to the grower after the commodity was sold by the buyer.

Sale by installment was previously agreed upon by the buyer and seller. It was the second important type of sale. The practice was that after the parties had agreed on a price, the buyer paid a part in cash at the time of delivery and the balance on the following market day.

A third method was the so-called "after delivery." This is a verbal agreement made between a grower and a buyer who have had long business dealings with each other. This type of sale is practiced in the local market, especially when the buyer has inadequate capital to purchase the produce. The price to be paid for the pineapples purchased under this method of agreement is usually the current market price in the locality at the time of disposal of the fruits. The payment is made on the following market day.

Approximate cost of marketing. Marketing costs in the main include handling at the local points, transportation, and selling expenses of the grower.

On the whole, the tenant-operators tended to spend less for marketing per unit of pineapple than owner-operators. Based on the survey, the costs of marketing incurred by the tenant-operator who sold locally amounted to ₱0.76 per hundred of pineapple fruits. Those who shipped to Manila had average marketing costs of ₱2.19 per hundred. The owner-operators who disposed of their commodity in the local market had an average expense of ₱0.83 per hundred of pineapple fruits, and those who shipped to Manila, ₱2.60 per hundred.

Marketing problems. The pineapple growers reported the following marketing problems:

a. Inadequate facilities for bringing the product from the farm to the market.

b. Alleged control of the prices by middlemen.

c. Competition among growers in the individual sale of the products.

d. Lack of consideration of customer's preference in varieties.

ERRATA

Page 377, line 9 from bottom, of number 7 (December, 1955), vol. 39, for "*Proutesta moesta* Westwood" read "*Proutista moesta* Westwood."

Page 385, line 18 from top, for "*Matthiola incena* R. Br. var. *annua*" read "*Matthiola insana* R. Br. var. *annua*."